

**BOTANICAL AND VEGETATION SURVEY
OF CARTER COUNTY, MONTANA**

BUREAU OF LAND MANAGEMENT-ADMINISTERED LANDS

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SUMMARY

The open plains of Carter County, Montana represent some of the most extensive and unbroken rangeland resources of the state, and among the lesser known in the biological literature. Baseline botany and vegetation baseline inventories were conducted on BLM-administered lands in the county to document these resources in terms of their biological diversity significance.

Eighteen Montana plant species of special concern have been documented in Carter County, half of them on BLM lands, including two species that grow exclusively in a small segment of the Great Plains. There are very few occurrences of these nine species, reflecting the lack of suitable habitat for most of them. A preliminary county flora of 507 species was also compiled.

Over seventy vegetation types (plant associations) have been documented in Carter County, the majority of them occurring on BLM lands. There is only one that is declining from a rangewide perspective (Plains cottonwood/western snowberry; *Populus deltoides*/*Symphoricarpos occidentalis*), and at least two plant associations dominated by bur oak (*Quercus macrocarpa*) that are peripheral and occur in no other places of the state. Detailed sampling and description is provided for 19 vegetation types that include the common plant associations on BLM lands.

The results point to a landscape-level diversity most closely linked to soils and topography features, including a high concentration of Montana plant species of special concern that require sandy habitat. Among the most distinguishing vegetation features of the county is the extensive natural vegetation on shale plains and contribution of thick-spiked wheatgrass (*Elymus lanceolatus*) among the prevailing vegetation types. These findings contribute to the body of baseline information on features in the Powder River Resource Area and in the state, documenting that many of the features are more common than previously known. They provide dimension to a state perspective that can only be found in this far corner of the state in the heart of the Great Plains.

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TABLE OF CONTENTS

SUMMARY	III
ACKNOWLEDGEMENTS	IV
INTRODUCTION	1
STUDY AREA	2
METHODS	8
Ecological Methods	8
Botanical Methods	11
Taxonomic Considerations	13
RESULTS	16
Ecological Results	16
FOREST AND WOODLAND VEGETATION TYPES	23
<i>Juniperus scopulorum</i> / <i>Oryzopsis micrantha</i> Plant Association	23
<i>Pinus ponderosa</i> / <i>Juniperus communis</i> Plant Association	25
<i>Pinus ponderosa</i> / <i>Pseudoroegneria spicata</i> Plant Association	27
<i>Pinus ponderosa</i> / <i>Schizachyrium scoparium</i> Community Type	29
<i>Populus deltoides</i> / <i>Symphoricarpos occidentalis</i> Community Type	31
<i>Quercus macrocarpa</i> / <i>Carex inops</i> ssp. <i>heliophila</i> Plant Association	33
<i>Quercus macrocarpa</i> / <i>Symphoricarpos occidentalis</i> Plant Association	35
<i>Artemisia cana</i> / <i>Pascopyrum smithii</i> Plant Association	37
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>P. smithii</i> (<i>Elymus lanceolatus</i>) Plant Association	39
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Opuntia polyacantha</i> Community Type	42
<i>Atriplex gardneri</i> / <i>Elymus lanceolatus</i> Plant Association	44
<i>Chrysothamnus nauseosus</i> / <i>Eriogonum pauciflorum</i> Community Type	46

<i>Sarcobatus vermiculatus</i> / <i>Elymus lanceolatus</i> Plant Association	48
GRAMINOID- AND FORB-DOMINATED VEGETATION TYPES	51
<i>Artemisia longifolia</i> / <i>Oryzopsis hymenoides</i> Community Type	51
<i>Calamovilfa longifolia</i> / <i>Carex inops</i> ssp. <i>heliophila</i> Plant Association	53
<i>Eleocharis palustris</i> (<i>E. xyridiformis</i>) Community Type	55
<i>Pascopyrum smithii</i> (<i>Elymus lanceolatus</i>) Plant Association	57
<i>Pascopyrum smithii</i> (<i>Elymus lanceolatus</i>) - <i>Nasella viridula</i> Plant Association	59
<i>Schizachyrium scoparium</i> - <i>Carex filifolia</i> Plant Association	61
<i>Spartina pectinata</i> Plant Association	63
<i>Stipa comata</i> - <i>Carex filifolia</i> Plant Association	65
BOTANY RESULTS	67
<i>Amorpha canescens</i> Pursh	71
<i>Asclepias ovalifolia</i> Decaisne	73
<i>Asclepias stenophylla</i> A. Gray	75
<i>Astragalus barrii</i> Barneby	77
<i>Astragalus racemosus</i> Pursh	79
<i>Chenopodium subglabrum</i> (S. Watson) A. Nelson	82
<i>Cyperus schweinitzii</i> Torrey	84
<i>Dalea villosa</i> (Nuttall) Sprengel	86
<i>Eriogonum visheri</i> A. Nelson	88
<i>Linaria canadensis</i> (L.) Chaz. var. <i>texana</i> (Scheele) Pennell	90
<i>Maianthemum canadense</i> Desf. var. <i>interius</i> Fern.	92
<i>Mirabilis hirsuta</i> (Pursh) MacM.	94
<i>Penstemon angustifolius</i> Nutt. ex Pursh	96
<i>Phlox andicola</i> Nuttall ex A. Gray	98
<i>Physaria brassicoides</i> Rydberg	100
<i>Psoralea hypogaea</i> Nuttall	102

<i>Quercus macrocarpa</i> Michaux	104
<i>Solidago ptarmicoides</i> (Nees) Boivin	106
LITERATURE CITED	110

FIGURES

Figure 1. Carter County Study Area	3
Figure 2. Carter County study area: Shaded relief with superimposed Ecoregional boundaries.	4
Figure 3. Walter-type climatic diagrams for Ekalaka and Albion, Montana.	6
Figure 4. Locations of Plant Association/Community Type Sampling, Carter County, MT.	10
Figure 5. Sensitive plant locations, Carter County, MT.	70

TABLES

Table 1. Sensitive plant species targeted for survey in Carter County.	12
Table 2. Synonymy of dominant plant species in Carter County, MT.	13
Table 3. Distinguishing characteristics between the two major rhizomatous wheatgrasses.	14
Table 4. Plant associations and community types sampled on BLM land in Carter County; arranged by decreasing lifeform stature and alphabetically within lifeform.	18
Table 5. Plant Communities/Associations matrix of Carter County, Montana referenced to the U. S. National Vegetation Classification:	19
Table 6. Occurrences of Montana plant species of special concern in Carter County, MT.	68

APPENDICES

APPENDIX A. SYNTHESIS AND COVER/CONSTANCY TABLES

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APPENDIX B. ELEMENT OCCURRENCE RECORDS

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APPENDIX C. PRELIMINARY FLORA OF CARTER COUNTY

APPENDIX D. PHOTOS AND ILLUSTRATIONS OF SENSITIVE PLANT SPECIES

INTRODUCTION

Systematic baseline botany and vegetation surveys were conducted on Bureau of Land Management (BLM)-administered land in Carter County, Montana. The primary purpose of botany surveys was to document sensitive plant species. The dual purposes of vegetation surveys were to document the rarest plant associations and the outstanding examples of relatively common plant associations.

The overall goal of this study is to develop basic botany and vegetation information for reference and application to resource management and conservation. This study contributes baseline information for determining which species and plant associations truly are uncommon, and the habitat settings of those species and communities.

Sensitive species provide potential agricultural, pharmaceutical and genetic resources. They are also indicators of special habitats and habitat conditions, providing a greater understanding to manage the landscape and its processes. Safeguarding the vulnerable members of the flora is instrumental in maintaining the complement of native species that are adapted to southeastern Montana, as well as in maintaining the ecosystems to which they belong. In this report, the term 'sensitive' is used in place of the adjective 'rare' to represent species recognized as either Sensitive or Watch by the BLM (USDA BLM 1996), or otherwise tracked as Montana plant species of special concern (Heidel 1997).

Plant associations are the communities of native plants and associated animals that depend on a common environment and on one another. As such, they are ecological integrators, providing information on both intrinsic environments (habitats) present in the landscape, and the ecological condition of these communities. An inventory of plant associations provides a biologist's census of the common species throughout an area, and may be used to gauge the breadth and sustainability of the natural communities.

This work does not represent exhaustive documentation of all sensitive plant locations and all plant associations in the county. It does identify the broad complement on BLM-administered lands, providing a baseline for reference at all levels of planning and operations.

STUDY AREA

The study area consists of BLM-administered lands in Carter County, in the southeastern corner of Montana. BLM holdings comprise the largest portion of federal lands in the county, and are surpassed in total acreage by private lands. BLM lands are concentrated in the southwestern 2/3 of the county in relatively remote rangelands. The more accessible and productive bottomlands are in private ownership. Other public lands include three Custer National Forest units (Chalk Buttes, Ekalaka Hills, and Long Pines of the Sioux District), that represent most of the forested uplands and the largest escarpments in the county. Montana State lands, including most sections 16 and 36, are scattered across the county (Figure 1).

Carter County has some of the most extensive range landscapes in the state. It had 89% rangeland in the 1970s; one of the twelve Montana counties with over 80% rangeland in the most detailed of recent land use surveys (USDA NRCS/SCS 1976). Most BLM lands in the county are within grazing allotments and are actively grazed. The primary ranching economy includes both cattle and sheep grazing. The history of grazing in the county dates to the early 1880s. More localized industries include bentonite mining on public and private lands in the southeast, logging in the Custer National Forest units in the north, and farming on private lands.

Geology and Landforms

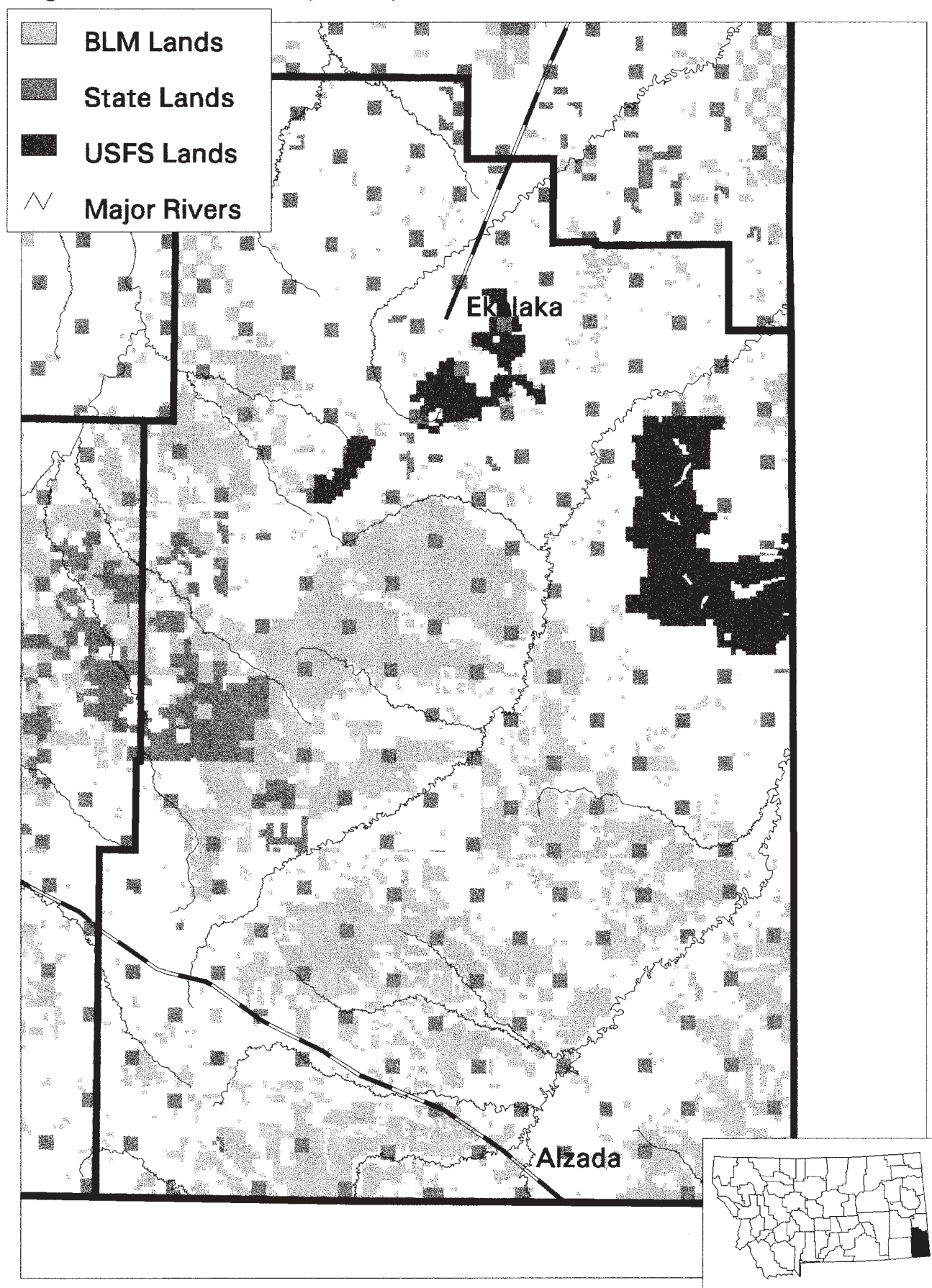
The Carter County landscape is characterized by low relief rolling sedimentary plains dissected by numerous drainages and dotted by weather-resistant sandstone or scoria-capped upland buttes and tablelands. The County lies within the Missouri River watershed. Most rivers flow in a northeasterly direction, including the Little Missouri River and its tributary Box Elder Creek. A limited area on the western edge of the county drains west to the Powder River. Tributary streams and the dominant ridge systems have a general northwest/southeast trend resulting in a predominance of southwest and northeast aspect slopes (Figure 2).

The open plains are made up of nearly level, horizontal Cretaceous formations, mostly shales and claystones. The most extensive are the Pierre Shale members and the most restricted is the Mowry Shale on the state line west of Alzada (Ross et al. 1955). Within some shale areas that are vast expanses of thin-soil, low productivity calcareous shales and claystone, are major outcrops of bentonite, a shrink-swell clay product of weathered volcanic ash. The forested escarpments and buttes are remnants of Tertiary sandstone formations. Scattered areas of badlands and river/stream breaks occur along Box Elder Creek and the Little Missouri River. The alluvial deposits are best developed along the Little Missouri River and certain tributaries including Willow and Thompson Creeks, as well as along the Boxelder Creek.

Soils

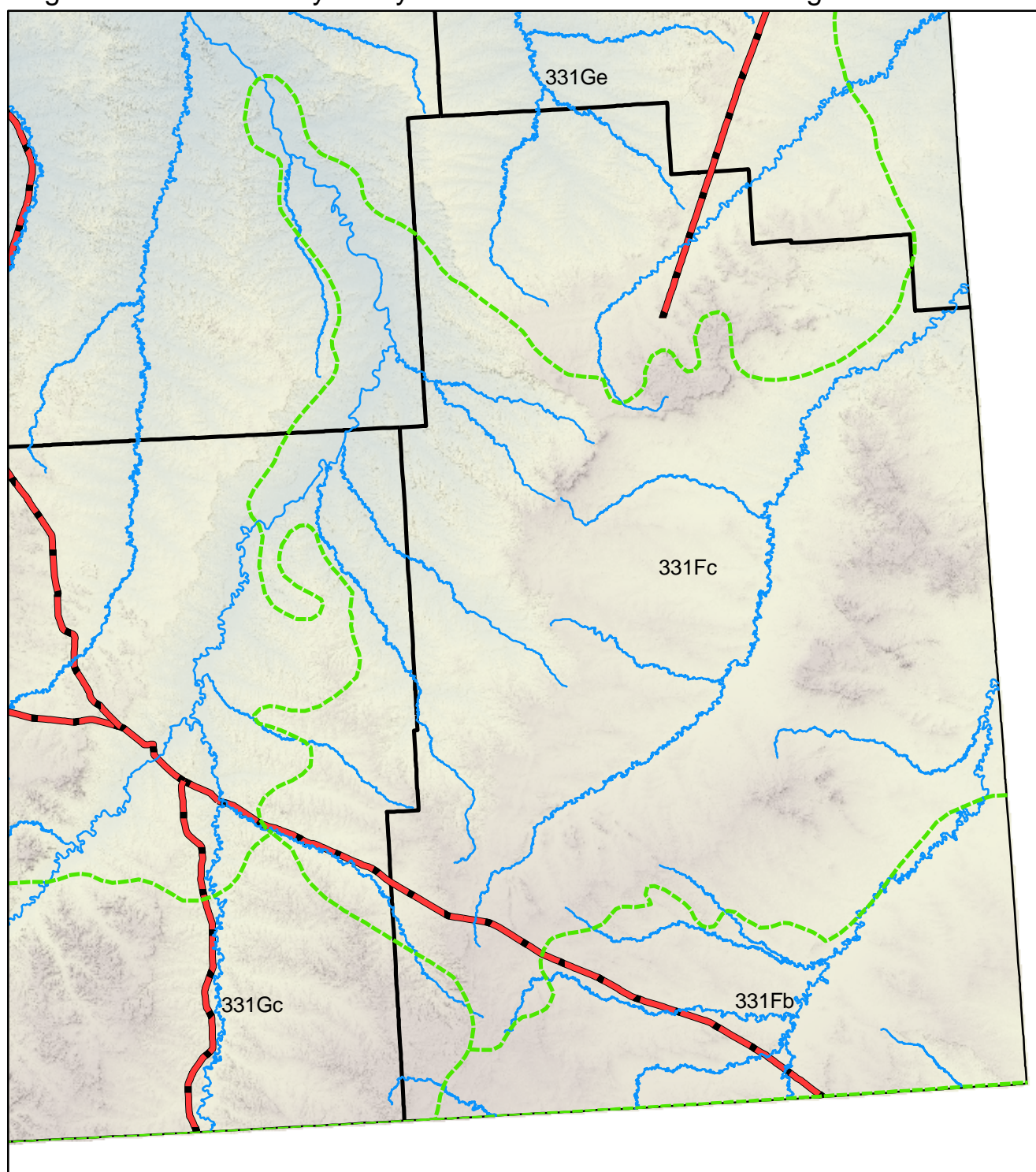
Dominant soils in the southwestern 2/3 of Carter County, where BLM lands are concentrated, are described as predominantly clayey entisols and aridisols (USDA Soil Conservation Service 1978).

Figure 1. Carter County Study Area



Montana Natural Heritage Program, February 4, 1998

Figure 2. Carter County Study Area: shaded relief with ecoregional boundaries

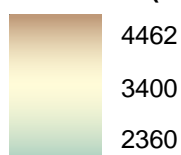


----- Ecoregional Units - Subsections ~~~~~ Rivers and Streams **Elevation (feet)**

331Fb Shale Scablands
 331Fc Pierre Shale Plains
 331Gc Powder River Basin/Breaks/Scoria Hills
 331Ge Montana Sedimentary Plains

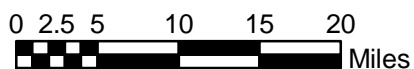
== Highways
 — County Boundaries

Scale of Miles
 Stateplane Single Zone
 Datum NAD83



Montana Natural
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Subsections from USFS Ecological Mapping.
 Elevation generated from 30 meter USGS DEM.



The soils are mostly residual and poorly developed, often little altered from the underlying sedimentary formations, mostly shales and claystones. In areas with badland and breakland topography, erosion greatly outpaces soil development. Alluvial soils are found along many tributaries on BLM land, but extensive alluvial plains along the major drainages are mostly on private land. Carter County BLM lands with sandy soils are relatively uncommon. These are found peripheral to the Custer National Forest units and isolated in the Humbolt Hills in northeast, in the Powder River headlands in the northwest and southwest, near Albion in the extreme southeast, and in the Finger Buttes area also in the southeastern quarter of the county.

A schematic way of aggregating environmental factors to present an overview of geology, landforms, and soils is depicted in maps of ecological regions (ecoregions). The study area is within a segment of the Great Plains that has been referred to as the Unglaciaded Missouri Plateau section (Fenneman 1931). A more current classification places the county wholly within Bailey's Great Plains-Palouse Dry Steppe (map label 331, Nesser et al. 1997), with two section divisions and two subsection divisions (see Figures 2 and 4 for these superimposed ecoregional boundaries). The Northwestern Great Plains Section (331F) includes the great majority of the county's land area, followed by the Powder River Basin Section (331G). The former is provisionally divided into Subsections on the basis of geological formations and degree of relief; the southern 1/3 of the county is Shale Scablands (331Fb), and the northern 2/3 is Pierre Shale Plains (331Fc). The latter is provisionally divided into the Powder River Basin /Breaks/Scoria Hills and the Montana Sedimentary Plains Subsections. These ecological region boundaries are discussed as they relate to vegetation on the following page.

Climate

The climate of Carter County is semi-arid (precipitation ranging from 10 to 15 inches) and temperate continental (4-7 months $> 10^{\circ}\text{C}$, coldest month $< 0^{\circ}\text{C}$). The bulk of precipitation comes in late spring-early summer, peaking in June. Rainfall during the summer is mainly from cloudbursts and thunderstorms, typically very light but sometimes accompanied by lightening, heavy hail, and occasionally, flash flooding. The growing season conditions are highly variable within and between years. It has been noted in adjoining Harding County that large diurnal temperature changes are frequent and accentuated by windy conditions (Visser 1914). Severe drought conditions are typical in two out of ten years (Johnson 1988). The growing season conditions are also highly variable with distance across the same region. In 1994, net January-June precipitation at Ekalaka (8.66 inches) was almost twice that of nearby Camp Crook (4.43 inches; from The Ekalaka Eagle of 8 July 1994). This climatic variation in turn is a strong influence on, in a complex fashion, the two major historic disturbance regimes of the prairie, ungulate grazing and wildfire.

All of this variation over time and space is averaged out in calculating totals and means. A comparison of mean climate values at two different places in the county shows very similar values and patterns. We include two diagrams (Walter-type; Figure 3) of the climates in two towns at opposite ends of the county, portraying a consistent climatic pattern that is taken to represent the plains of Carter County in general. The period and magnitude of the growing season's relative drought is the area in Figure 3 delineated by the temperature curve's rise above the precipitation curve, and is quite similar between the two reporting stations; even their relatively dry periods exhibit great similarity.

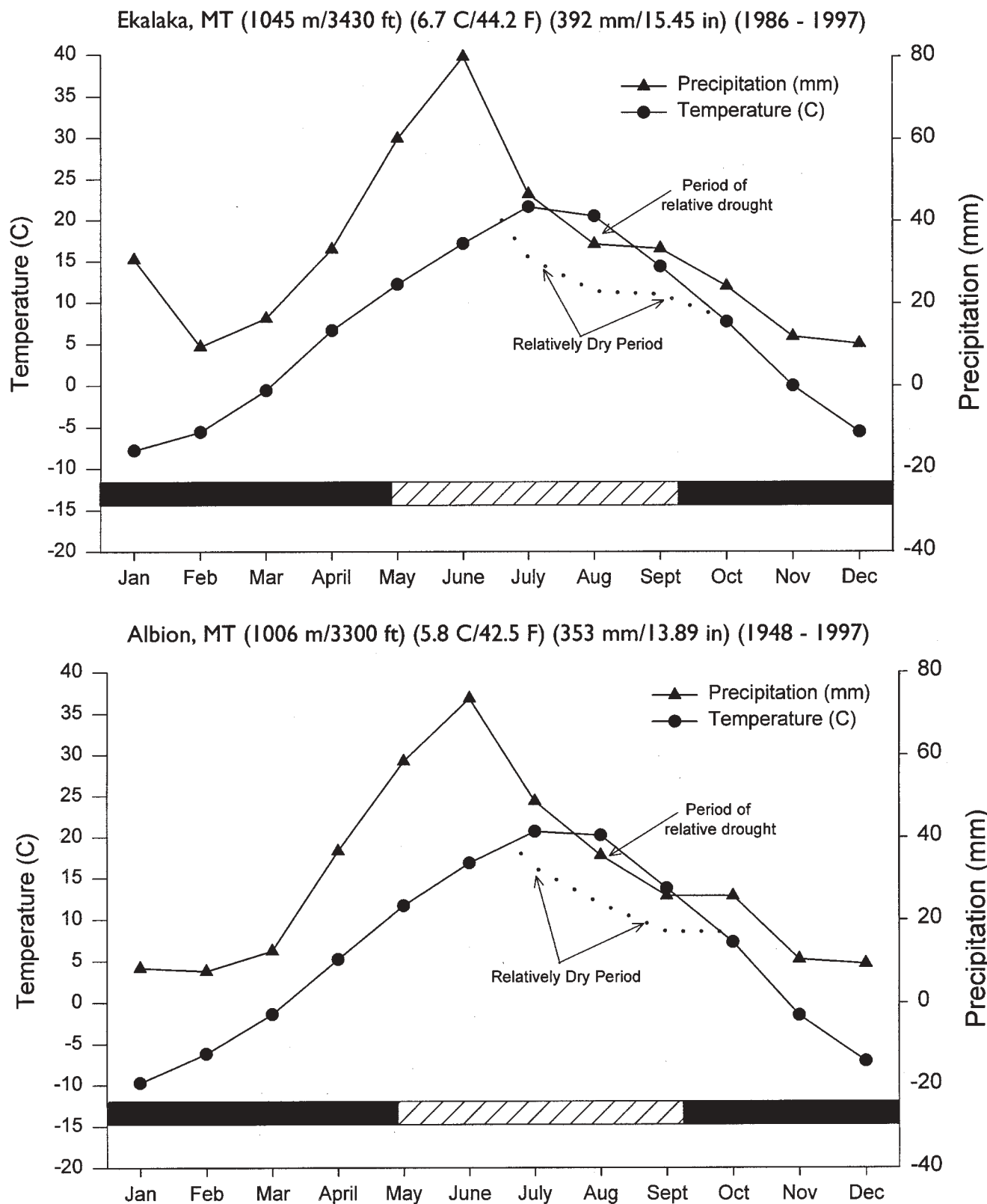


Figure 3. Walter-type Climatic Diagrams for Ekalaka and Albion, Montana.

Weather Station Location (Elevation) (Mean Annual Temperature) (Mean Annual Precipitation) (Period of Observation)
 Intensity and duration of relative humid season indicated by area between lines where monthly march of precipitation exceeds monthly march of temperature. The intensity and duration of a relative droughty season is indicated by the area between lines where monthly march of temperature exceeds the monthly march of precipitation. The difference between lines represents intensity and width is proportional to its duration. Axes are explicitly scaled so that 10 C = 20 mm (Walter 1973). Similarly, the intensity and duration of relative dry periods is represented by the area where the monthly march of temperature exceeds the monthly march of precipitation with the axes scaled so that 10C = 30 mm (Walter 1973). Note: For relative dry periods, only the monthly march of precipitation is shown where it is below the monthly march of temperature.

Vegetation

Vegetation patterns in Carter County primarily reflect differences in soils, geology, and topographic position. Vast rolling plains with fine-textured, shale-derived soils are characterized by steppe vegetation (shrub- and grass-dominated) in expressions that are conditioned by slope position, past fires, and grazing regimes. Eroded shale-ridge systems and slope outwash support communities dominated by specialized, drought and/or salt tolerant shrubs or herbs. Bentonite and shale ridge systems and adjacent river terraces near Alzada support Montana's only oak woodlands. Ponderosa pine grows mainly on sandstone outcrops.

Steppe is defined as a climatically controlled vegetation type where the prevailing soils are too dry for trees, and perennial grasses are well represented. In Carter County, both grassland steppe and shrub steppe, where abundant shrubs form a higher layer, are present. The prevalence of grasslands and shrublands across Carter County is apparent at a glance on the vegetation cover type map of Kuchler (1964). The magnitude of growing season drought and timing of precipitation are hypothesized to be the two strongest climatic factors structuring the composition of steppe landscapes (Daubenmire 1978). Carter County lies in the middle of mixed-grass prairie (steppe) which extends from the Rocky Mountains to the Dakotas and where mid-sized grasses and grass-like plants predominate over short-grass or tall-grass species. Farther east, with gradually increasing amounts of precipitation, tall-grass prairie lines the eastern margin of the Great Plains and extends into the Midwest.

The statewide vegetation cover type information that has recently been compiled by the University of Montana shows vegetation patterns that correspond with the distribution of BLM-administered lands in the county. BLM lands are most concentrated in areas of xeric shrubland and areas mapped as badlands, the latter representing extremely sparse grasslands and shrublands. Grasslands on clay soils are usually dominated by rhizomatous wheatgrasses (genera including *Elymus* and *Pascopyrum*) while those on sandy soils generally have a higher component of needle- and-thread (*Stipa comata*). Communities dominated by the warm season grass little bluestem (*Schizachyrium scoparium*) are most common on sandy substrates, but may also occur on alluvial substrates eroded from shales. Shrub communities on alluvial terraces that have fine textured soils are usually dominated by black greasewood (*Sarcobatus vermiculatus*) or Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), while similar positions with sandy soils support silver sagebrush (*Artemisia cana*).

Previous vegetation studies in Carter County have been conducted by the U.S. Forest Service on upland escarpments, representing less than 5% of the county area. Studies in adjoining counties have been of limited extent or applicability for cataloguing or characterizing features across the Carter County landscape. This study is a huge stride in creating a systematic vegetation resource inventory, cataloguing and describing major types on BLM-administered lands, along with the field data and information layers for understanding their place on the landscape.

METHODS

Ecological Methods

Preparation for plant ecology studies in Carter County began with compilation of existing information on the vegetation of Carter County, and southeastern counties in general. There is no published literature from BLM lands in the county, and few unpublished reports. We drew from a running compilation of Montana vegetation references started in the work of Bourgeron et al. (1988), with major additions for southeastern Montana represented in vegetation classification studies through the U.S. Forest Service (Hansen and Hoffman 1988) that include information from Carter County. This has been used to produce working drafts of a list of state plant associations (represented in Bourgeron and Engelking 1995) and the start of regional vegetation classifications (e.g., Cooper et al. 1995).

Systematic survey was planned to include each large area of BLM-administered land, the range of substrates as represented by bedrock geology (Ross et al. 1955), and the observed array of habitat types. Landforms and surface water features depicted on BLM surface management maps (1:100,000) and observed in the field were also considered in order to traverse the hydrological and topographic gradients. Finally, U.S.G.S. topographic maps (7.5i) and BLM aerial photographs (black and white or color at 1:15,840) were carried into the field as an aid in determining routes and selecting sites. Bureau of Land Management surface management maps (1:100,000) were used to delimit BLM-administered lands.

Besides the aerial photographs and other references, we drew heavily upon the road log notes kept by Keith Dueholm of vegetation types encountered in the 1996 field season during sensitive species survey. In addition, we had use of a land-cover map produced by the EROS Data Center (Brookings, SD) from Landsat Thematic Mapper imagery (30 m pixel resolution) that included all of Carter County. It showed the distribution of land cover types, e.g. cropland, forest, grassland; in order to focus sampling in settings of extensive rangeland.

Vegetation and site characteristics were documented for 52 circular 1/10 acre plots according to methodology described in Cooper et al. (1995); see Figure 4 for sampling locations. The criteria for selecting sampling sites included uniformity in the vegetation and setting, relative absence of exotic species, and high condition. Standard MTNHP community survey forms were used to record plot data including location, environmental features (e.g. elevation, slope, landscape position, substrate, and ground cover) and ocular canopy cover estimates (Daubenmire 1959) for all vascular plant species and common mosses and lichens. We sought to sample high quality condition examples of extensive and rare plant community types. This meant that some uncommon community types were not sampled at all (e.g. *Fraxinus pensylvanicus* woodlands), while other widespread types were undersampled (e.g. *Artemisia cana/Pascopyrum smithii*).

We also considered any established study areas that might be appropriate vegetation benchmarks. The two sites in Carter County that were studied as part of the statewide inventory of soils and vegetation at near-pristine sites (Ross et al. 1973) were in the Chalk Buttes. There are also two existing exclosures on BLM lands and they were visited in the course of the study, though they were set up in broken topography that did not necessarily represent a uniform environment for vegetation sampling.

Soil samples (top 1 dm) were collected from each plot. To stretch the budget farthest, the most detailed soils test were run on the samples from the most uncommon vegetation types or vegetation types thought to be strongly associated with soils (e.g. acid shales or salt affected soils). For common vegetation types, ostensibly having no particular associations with substrate, only pH and conductivity, were assigned. Where vegetation types were suspected to be linked to soil characteristics or the literature indicates such to be the case, tests were assigned on a sample-by-sample basis. For example, the *Stipa comata* ñ *Carex filifolia* plant association is reported to occur on coarser textured, circumneutral soil, so texture analysis and pH tests were apportioned to many of the samples characterized as being from this vegetation type. All soil testing was performed by the Montana State University Soil Testing Laboratory in Bozeman.

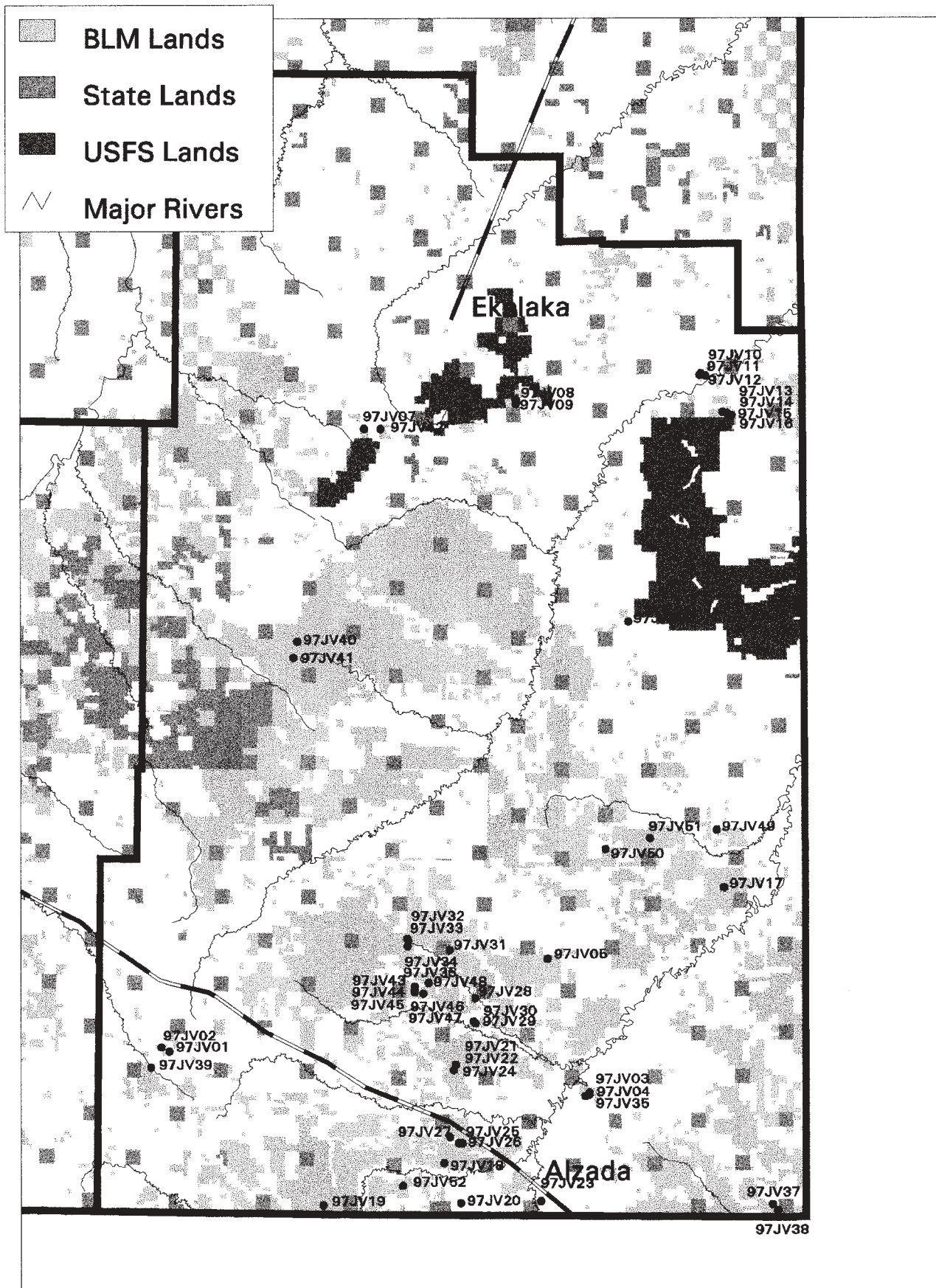
The vegetation data set was analyzed using the STRATA program of ECADS. (Ecological Classification and Description System), a USDA Forest Service ecological sampling package revised from the previous ECODATA program (Cooper et al. 1995). Plots were subjectively placed in plant association or community types based on selection criteria (relative homogeneity, optimal condition and development, nominal exotic species component) also considering similarity to types described in the literature.

Synthesis and cover/constancy tables (Appendix A) were generated after data entry for each type. The tables utilize 6 letter acronyms to designate plant species. These are generally the first three letters of the genus name followed by the first three letters of the specific epithet, thus *Pascopyrum smithii* is indicated as PASSMI. In a few cases, modern synonymy has not been incorporated into database tables utilized by E.C.A.D.S. and acronyms for older names must be used in the constancy/cover tables. Sometimes accurate identification of species in the plots was difficult or impossible and acronyms represent determination only to the level of genus or life category. A complete listing of acronyms and the scientific names they indicate is provided in Appendix B.

Results are presented in a framework consistent with national classification standards adopted by federal agencies that include the BLM. The rationale and structure behind them is described by the Federal Geographic Data Committee (1997) and the Ecological Society of America - Vegetation Classification Panel (Loucks et al.1997). This is being used, e.g., in the USGS Gap Analysis Program (GAP) for mapping vegetation of the United States in order to assess the conservation status of wildlife species and their habitats. At lower levels of classification, most units of the Alliance and Plant Association levels of the classification have been crosswalked between western states, but the definitions of these two floristic levels are still under discussion.

We have placed all our floristically defined units (alliances, plant associations, and communities) within the physiognomic units of the National Classification and provided a key to these upper levels. There is still no unanimous definition of the floristic levels, alliance and plant association (Loucks 1998). We were not able to generate keys to these levels because of this and the limited information from eastern Montana in general. Standardized delimiting criteria and keys are needed in order for users of the classification to unambiguously and consistently key to the same taxonomic unit.

Figure 4. Locations of Plant association/community type sampling, Carter Co.



Montana Natural Heritage Program, February 4, 1998

Botanical Methods

Prior to fieldwork in 1996 and 1997, the Biological Conservation Database was queried for the most current information on occurrences of plant species of special concern (Heidel 1996, 1997) known from Carter County. The resulting lists of species became the primary study targets, with particular emphasis on Sensitive or Watch species as recognized by the BLM (USDI BLM 1996).

In the course of the study, any discovery of a Montana plant species not previously known from the county, or a native species not previously known from the state, represented potential additions to the study set. Studies conducted elsewhere in southeastern Montana were also used for reference in identifying species targets and habitat requirements (Heidel and Dueholm 1995, Heidel and Marriott 1996). We were also able to draw from the various works in the three-state area, including graduate theses, the Visher (1914) publication, and agency baseline studies, in considering other prospective plant species of special concern which might be found in Carter County. The most complete source of plant distribution information is found in "Atlas of Flora of the Great Plains" (Great Plains Flora Association 1977). It would seem to indicate that the state lines have been a barrier to plains plants when in fact the break in county-of-distribution records at the state and county lines reflects the patterns and idiosyncrasies of study over the decades.

We note that there are no plant species that are federally threatened or endangered in Carter County; only species recognized as sensitive or watch by federal land managing agencies. One species was recognized as BLM sensitive and five as watch. Many occurrences were recent records scattered across Custer National Forest lands, or from Medicine Rocks State Park. In addition, there were a few other occurrences that were historical (pre-1950) records with imprecise location data. In addition, there were several other Carter County species that have been dropped from consideration in recent years as species of special concern based on the numbers of occurrences and apparent absence of threats (*Carex torreyi*, *Haplopappus multicaulis*). In addition, there are reports of bittersweet (*Celastrus scandens*) in the county that have not been documented, and there are two watch species known from the county that are pending status review (*Agastache foeniculaceum*, *Geum canadense*).

Sensitive plant species surveys were conducted by Keith Dueholm throughout the summer months in 1996 and by the authors of this report in the summer in 1997 with emphasis on the first half of the growing season. Survey routes were chosen based mainly on two sets of criteria:

Search for the species survey targets by seeking their various potential habitats, and

Screening the full array of habitats on the landscape, which took place in the second season as part of the plant communities work, to consider prospective species of special concern not previously known from the county (see ecology methods).

In addition, revisits were made to known occurrences if the documenting information was incomplete, or if the location was not detailed and it was suspected that the population occurs on BLM-administered land.

Table 1. Sensitive plant species targeted for survey in Carter County.

SPECIES Scientific nameCommon name	BLM Status ¹	Global Rank State Rank ²	Habitat ³
<i>Amorpha canescens</i> Lead plant	-	G5 SH	Well-drained grassland
<i>Asclepias ovalifolia</i> Ovalleaf milkweed	Watch	G5? S1	Open pine woods; possibly associated with drainageways or sandy outwash
<i>Asclepias stenophylla</i> Narrowleaf milkweed	Watch	G4G5 S1	Sands and sandy grassland; often with scattered pine
<i>Astragalus barrii</i> Barris milkvetch	Watch	G3 S3	Calcareous sparsely-vegetated shale outcrops
<i>Astragalus racemosus</i> Raceme milkvetch	Watch	G5T4 S1	Alkaline flats
<i>Celastrus scandens</i> Bittersweet	-	G5 S1	Woody draws and gallery forest. Note: There is no county record, only a report.
<i>Chenopodium subglabrum</i> Smooth goosefoot	Watch	G3 S1	Sand dunes and sandy open river terraces
<i>Cyperus schweinitzii</i> Schweinitzi flatsedge	Watch	G5 S1	Sand dunes
<i>Dalea villosa</i> Silky Prairie Clover	Watch	G5T? S1	Sands and sand dunes
<i>Linaria canadensis</i> Blue toadflax	Watch	G4G5 S1	Alkaline flats, possibly sandy grassland
<i>Maianthemum canadense</i> Wild lily-of-the-valley	-	G5T4 S1	Deciduous woodland
<i>Mirabilis hirsuta</i> Hairy four-o'clock	Watch	G5 S1	Sandy grassland
<i>Penstemon angustifolius</i> Narrowleaf penstemon	Watch	G5 S2	Sandy grassland, sands and sand dunes
<i>Phlox andicola</i> Plains phlox	Watch	G4 S1	Sandy open pine woodland and grassland
<i>Physaria brassicoides</i> Double bladderpod	-	G5 S1	Sandy outcrops, possibly shale outcrops
<i>Quercus macrocarpa</i> Bur oak	Sensitive	G5 S1	Shale uplands and gallery forest, possibly limestone uplands
<i>Solidago ptarmicoides</i> Prairie aster	-	G5 S1	Sandy uplands, possibly limestone uplands

¹From USDI BLM 1996

²From Heidel 1997

³From Montana Natural Heritage Program 1995; with revisions

When populations of Montana plant species of special concern were encountered, MTNHP field survey forms were filled out and the populations were mapped. Information was recorded on location, habitat (associated vegetation, landscape position, soils), demography (population numbers and area covered), plant biology (phenology, vigor, reproductive success), and population trends.

In the course of ecological and sensitive plant fieldwork, lists of the general flora of Carter County were compiled. The primary references used to key out plants in the field were Dorn (1984, 1992) and Great Plains Flora Association (1986). Specimens were collected when field identification was difficult, and as vouchers to document populations of sensitive and other notable species. Specimens will be deposited at the herbaria of Montana State University (MONT) and duplicates will be sent to the University of Montana (MONTU). An annotated floristic list of Carter County (Appendix C) was compiled from records of 1996 and 1997 BLM surveys, earlier MTNHP surveys of Custer National Forest lands in the county (Heidel and Dueholm 1995), other MTNHP records, and from distribution maps in Booth (1966) which represent collections at MONT.

Taxonomic Considerations

Plant scientific names used in this report generally match those found in manuals of the Montana flora (Booth 1950, Booth and Wright 1966, Dorn 1984). However, we incorporate the taxonomic treatments of Kartesz (1994) to maintain consistency with other states and current taxonomic research. This means incorporating unfamiliar-sounding names for some dominant and indicator species, particularly the grasses in the Triticeae (*Agropyron*, and *Elymus* in the traditional sense). Thus, western wheatgrass, listed as *Agropyron smithii* in Booth (1950) and as *Elymus smithii* in Dorn (1984), becomes *Pascopyrum smithii*. For ease of communication in informal situations, use of common names may be preferable for such controversial groups (A. Beetle, pers. commun.) Table 2 presents the synonymy for common dominant and indicator species encountered in Carter County plant communities and these synonyms are listed in the headings of the plant association and community type descriptions. Synonymy is also provided in the Carter County floristic list (Appendix C) when a name is used other than those in the Montana floras (Booth 1950, Booth and Wright 1966, Dorn 1984).

Table 2. Synonymy of dominant plant species in Carter County, MT.

Common name	Booth (1950)	Dorn (1984)	Kartesz (1994)
Thick-spiked wheatgrass	<i>Agropyron dasystachyum</i>	<i>Elymus lanceolatus</i>	<i>Elymus lanceolatus</i>
Western wheatgrass	<i>Agropyron smithii</i>	<i>Elymus smithii</i>	<i>Pascopyrum smithii</i>
Bluebunch wheatgrass	<i>Agropyron spicatum</i>	<i>Elymus spicatus</i>	<i>Pseudoroegneria spicata</i>
Little bluestem	<i>Andropogon scoparius</i>	<i>Andropogon scoparius</i>	<i>Schizachyrium scoparium</i>
Long-stolon or sun sedge	<i>Carex pensylvanica</i>	<i>Carex pensylvanica</i>	<i>Carex inops</i> ssp. <i>heliophila</i>
Green needlegrass	<i>Stipa viridula</i>	<i>Stipa viridula</i>	<i>Nessula viridula</i>

Taxonomic considerations of another sort involve the two rhizomatous wheatgrasses, thick-spiked wheatgrass (*Elymus lanceolatus*) and western wheatgrass (*Pascopyrum smithii*), which are both important elements of plant communities in Carter County and its rangeland resources. A summary of their distinguishing features is presented below (Table 3).

Table 3. Distinguishing characteristics between the two major rhizomatous wheatgrasses.

	WESTERN WHEATGRASS (<i>Pascopyrum smithii</i>)	THICK-SPIKED WHEATGRASS (<i>Elymus lanceolatus</i>)
INFLORESCENCE CHARACTERISTICSS ⁴		
Glume width	Glumes tapering from below the middle into an awn-tip	Glumes normally widest above the middle, the tip acute to acuminate
Lemma surface	Lemmas <i>often</i> glabrous	Lemmas strongly pubescent
Lower sheath surface	Lower sheaths <i>often</i> glabrous	Lower sheaths <i>usually</i> pubescent, although often very finely so
VEGETATIVE CHARACTERISTICS ⁵		
Leaf blade	Glaucous bluish-green	Dull green
Leaf blade angle	Attached at 45 degree angle to stem	Attached at less than 45 degree angle to stem
Ligule	To 0.5 mm long; truncate, lacerate or ciliate	To 1 mm long; obtuse
Auricle	Sometimes purplish at base	-
Sheath	Prominently veined, glabrous	Smooth or slightly scabrous, midrib often continuing partway down

They are difficult to distinguish, especially in vegetative condition, they have overall similar growth forms and stature, they sometimes grow intermixed in various proportions, and are reported to hybridize (Great Plains Flora Association 1986). In 1997 the production of flowering culms, which have the key characteristics needed for determination, was highly reduced so that the information we present has mixed levels of certainty in this matter despite work with voucher specimens, herbarium reviews, and consultations.

Community Classification Considerations

Thick-spiked wheatgrass is described as adapted to cooler, wetter conditions as effected by climate and soils, and becomes dominant to the north in Canadian grasslands (Coupland 1961). It has also been described as adapted to upland sites with fine-textured soils; often saline-alkaline soils (Jorgenson 1979) that become more common with decreasing rainfall to the west. It stands to reason that thick-spiked wheatgrass is a major component of rangelands in the northwest sector of the Great Plains, namely in Montana.

⁴From Great Plains Flora Association (1986)

⁵From Looman (1982)

However, few plant communities have been described in Montana with thick-spiked wheatgrass (*Elymus lanceolatus*) as the named dominant or codominant. Western wheatgrass is probably the more common plant throughout most of Montana. wheatgrass appears to be the dominant species in some communities on fine textured, shale-derived soils that predominate on BLM lands in southern Carter County, consistent with its distribution as a dominant or codominant in the Yellow Water Triangle of Petroleum and Fergus counties (Jorgenson 1979).

We provisionally describe two halophytic associations codominated by *Elymus lanceolatus*: *Atriplex gardneri*/*Elymus lanceolatus* and *Sarcobatus vermiculatus*/*Elymus lanceolatus*. The latter is previously reported in the literature by Jorgenson (1979). We also refer to this species as dominant or codominant in two other associations, based on our limited sampling data, but treat them conservatively under the names: *Artemisia tridentata* ssp. *wyomingensis*/*Pascopyrum smithii* p.a. and *Pascopyrum smithii* p.a. They are widely published in the literature as western wheatgrass communities. Finally, we refer to thick-spiked wheatgrass as the dominant in the *Pascopyrum smithii*-*Nasella viridula* p.a. that is widely-recognized as a discrete plant association. In Carter County, the shale ridge area in which it was documented may represent an atypical setting such that the thick-spiked wheatgrass dominance does represent a distinct plant association. To unequivocally resolve the community classification status of the later three types, the taxonomic status must first be resolved by collecting voucher material with inflorescences from vegetation study sites and then additional datasets are needed to support recognition of new types.

There is a separate, related community classification question. It can only be addressed after resolution of the preceding questions. Some plant association/community type keys (e.g. DeVelice et al. 1995) utilize cover by either species interchangeably to arrive at types named after western wheatgrass (*Pascopyrum smithii*). This idea of wheatgrass species pairs as ecological equivalents has not been rigorously examined, nor has the possibility that they are distinct plant associations. We note *Elymus lanceolatus* dominance and codominance in the community descriptions and vegetation sampling data as representing our best judgement, while recognizing the need for additional information to resolve these questions.

RESULTS

Ecological Results

The following descriptions of 19 vegetation types represent most of the common, well-developed habitats on BLM-administered lands in Carter County. These include 7 forest and woodland types, 6 shrubland types, and 8 graminoid- and forb- dominated types (Table 4). They are based on 52 semi-quantitative plots that were established to document plant associations and community types on BLM land in Carter County. The plots document representative stands judged to be in the highest range condition and/or with the least weed infestations. Each vegetation type is described in terms of environment, vegetation composition, and other observations.

Of direct benefit to statewide vegetation classification, we document new plant associations, recommend global and state rank changes to existing plant associations, and identify classification research needs. There are three plant associations that are new to state vegetation classification literature. There are at least fifteen vegetation types that were considered potentially imperiled or vulnerable on a rangewide basis in provisional rankings (GRANKS=G2 or G3). This study and related studies have provided the basis for changing the ranks in several cases to reflect that these community types are more widespread than previously known. There are five plant associations warranting classification research as to the fidelity and significance of the rhizomatous wheatgrass component as it occurs in association with *Artemisia tridentata* ssp. *wyomingensis*, *Atriplex gardneri*, *Sarcobatus vermiculatus*, *Nasella viridula* and as a single-species community dominant.

In total, more than seventy distinct vegetation types in Carter County are documented or reported to date, not just on BLM lands. The compiled information from this study, from observation, and from the literature is presented in Table 5. These may be underestimates of community diversity given that there are many miles of riparian corridor, bottomlands, and woody draws that are in private ownership that were not considered. County-wide vegetation surveys have not been conducted for other Montana counties so there is not a basis for comparing these results, but given the topographic relief, wide variety of substrates, and extensive unbroken habitat, this number is likely to represent a high figure. We highlight the significance and rank recommendations for plant associations below, referring to the total number of documented types in the county unless otherwise stated.

Forested types are sparsely represented on BLM holdings. Despite their limited extent, forest and woodland types warrant attention as important wildlife habitat and because of their slow regeneration. In addition, four of the six forest types on BLM lands in the county are currently rated as potentially vulnerable (G3). In the course of this and other studies we encountered many examples of two of these, PINPON / CARINO and PINPON / SYMOCC, and suggest that these types are more abundant and widespread than previously known, though they could be impacted by invasion of exotic species. We suggest their rank be changed to potentially secure (G4), on the basis of the southeastern Montana reconnaissance alone.

Of the 10 woodland vegetation types, 5 are ranked G3 or higher, one is G4 and 4 have their G-rank in question. All of these types are threatened by the invasion of exotics to varying degrees. Even the JUNSCO/ORYMIC type occurs in a landscape where yellow sweetclover (*Melilotus officinalis*) is

aggressively expanding over what appears to be inhospitable terrain. The wooded vegetation types associated with moister environments, particularly riparian zones and woody draws (e.g. *Populus deltoides* / *Symphoricarpos occidentalis*), are the least well-represented on BLM land and have been extensively converted to cropland or invaded by exotic species (*Bromus inermis*, *Poa pratensis*, and annual brome grasses). The G-ranks of these mesic vegetation types should be G3 or rarer. The upland types (e.g. JUNSCO / ORYMIC, PINPON / PSESPI, PINPON / SCHSCO), though they occur predominantly as small patches occasionally ranging to large patches, have many occurrences and are secure to the extent all of them should be rated at least G3G4.

Shrub-dominated communities are extensive in Carter County, particularly in the southern 2/3 of the county where substrates are mainly shale. The three new plant associations documented in this study are all shrub-dominated. The most common upland shrub type is the ARTTSW/PASSMI type. It freely intergrades with grassland and with sparse vegetation types. This may be among the most extensive examples in the state. It is one of the major types with a classification question that hinges on the habitat specificity and distinction between the rhizomatous wheatgrasses. The most common lowland type is the ARTCAN / PASSMI type on floodplains and terraces. It is much better-represented on private holdings outside the study area. Despite their low G-ranks and ubiquity in the landscape these types are under continual threat of exotic species invasion and can also be degraded in attempts to increase productivity through contour furrowing.

Of the 34 herb-dominated or sparse vegetation types, 10 are ranked vulnerable or imperiled rangewide (G1-G3), 10 have no definitive ranking and the remainder are demonstrably secure (G4 or G5). On the basis of our Carter County survey we will recommend several rank changes among this first group, particularly for the *Schizachyrium scoparium* / *Muhlenbergia cuspidata*, *S. scoparium* / *Carex inops*, and *S. scoparium* / *C. filifolia* plant associations. Even though these types all occur as small patches, their positions among secondary range in the landscape make them less vulnerable to weed invasions and degradation. The *Puccinellia nuttalliana* and *Artemisia longifolia* / *Oryzopsis hymenoides* types, are rated G1? and G2 respectively. They are appropriate to rank G3 or greater based on statewide sampling, reconnaissance and correspondence with neighboring Heritage programs.

It was beyond the scope of this baseline survey to produce a county vegetation key. In the future, it might be an ideal interagency project to meld the several vegetation classifications that treat the southeastern Montana landscape and produce an integrated classification with a working key. This would require additional sampling in Carter and adjacent counties, and compilation of all cover-based community data collected elsewhere in Carter County (e. g. Hansen and Hoffman 1988, Hansen et al. 1995). It might also include or consider data from surrounding counties and states, and from Natural Resource Conservation Service (NRCS/SCS) vegetation production data into a common format (e. g. ECODATA or ECADs).

The plant associations described in the following text are grouped by the tallest species among the dominants as presented in Table 4. Scientific names are used throughout the following descriptions, and are cross-referenced by common names and six-letter acronyms in Appendix B.

Table 4. Plant associations and community types sampled on BLM land in Carter County; arranged by decreasing lifeform stature and alphabetically within lifeform.

Lifeform	Number assigned to sampled plots ¹	Current G/S Rank	Recomm. G Rank Change
Tree-dominated Plant Associations and Community Types			
<i>Juniperus scopulorum</i> / <i>Oryzopsis micrantha</i>	41	G3/S3	G3G4
<i>Pinus ponderosa</i> / <i>Juniperus communis</i>	6, 8	G4/S3	-
<i>Pinus ponderosa</i> / <i>Juniperus horizontalis</i>	10, 16	G3/S3	-
<i>Pinus ponderosa</i> / <i>Schizachyrium scoparium</i>	9	G2/S2	G3G4
<i>Populus deltoides</i> / <i>Symphoricarpos occidentalis</i>	28	G2G3/S?	-
<i>Quercus marcocarpa</i> / <i>Carex inops</i>	20	G1Q	-
<i>Quercus macrocarpa</i> / <i>Symphoricarpos occidentalis</i>	23	?	-
Shrub-dominated Plant Associations and Community Types			
<i>Artemisia cana</i> / <i>Pascopyrum smithii</i>	7, 42	G4/S4	-
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Pascopyrum smithii</i> (<i>Elymus lanceolatus</i>)	4, 5, 14, 19, 27, 38, 45	G3/S3	G3G4
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Opuntia polyacantha</i>	51, 52	New	G3G4
<i>Atriplex gardneri</i> / <i>Elymus lanceolatus</i>	31, 43, 47	New	G3Q
<i>Chrysothamnus nauseosus</i> / <i>Eriogonum pauciflorum</i>	21, 22, 29, 35	New	-
<i>Sarcobatus vermiculatus</i> / <i>Elymus lanceolatus</i>	3, 25, 33, 36, 48	G3/S3	G3Q
Grass- and Forb-dominated Plant Associations and Community Types			
<i>Artemisia longifolia</i> / <i>Oryzopsis hymenoides</i>	40	G2/S2	G3Q
<i>Calamovilfa longifolia</i> - <i>Carex inops</i>	12, 18	G3/S3	G3Q
<i>Eleocharis palustris</i> (<i>Eleocharis xyridiformis</i>)	49	G5/S5	-
<i>Pascopyrum smithii</i> (<i>Elymus lanceolatus</i>)	26, 32, 34, 44	G3G5Q/S4	G3G5Q
<i>Pascopyrum smithii</i> (<i>Elymus lanceolatus</i>) - <i>Nasella viridula</i>	30, 45	G4Q/S3	G4Q
<i>Schizachyrium scoparium</i> - <i>Carex filifolia</i>	1, 13	G4/S3	-
<i>Spartina pectinata</i>	24, 39	G3/S3	-
<i>Stipa comata</i> - <i>Carex filifolia</i>	2, 11, 15, 37, 50	G5/S4	-

1. Complete reference to plot number for tracking purposes includes the prefix NHMTECCC97JV00__ as detailed in Appendix A.

Table 5. Plant Communities/Associations of Carter County, Montana.

Plant associations/communities which have been documented in this study are shaded. All are arranged alphabetically within dominant lifeform types.

Plant Association/ Community Type	National Vegetation Classification Structure; Physiognomic Criteria					Observer(s) ¹	Literature Citation(s) ²	G Rank:
	Class	Subclass	Group	Subgroup	Formation			

FORESTED TYPES (Trees with crown usually touching, canopy cover usually exceeding 60%)

<i>Acer negundo</i> / <i>Prunus virginiana</i>	Forest	Deciduous	Cold-deciduous	Natural / Semi-natural	Temporarily flooded	B.H. & S. C.	Hansen et al. 95	3
<i>Populus tremuloides</i> / <i>Berberis repens</i>	Forest	Deciduous	Cold-deciduous	Natural / Semi-natural	Montane or boreal	S.C.	H & H 88;	3
<i>Populus tremuloides</i> / <i>Cornus sericea</i>	Forest	Deciduous	Cold-deciduous	Natural / Semi-natural	Temporarily Flooded	S.C.	Hansen et al. 95;	3
<i>Pinus ponderosa</i> / <i>Carex inops</i>	Forest	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	S.C.	H & H 88;	3
<i>Pinus ponderosa</i> / <i>Juniperus communis</i>	Forest	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	J.V.	H & H 88;	4
<i>Pinus ponderosa</i> / <i>Prunus virginiana</i>	Forest	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	K.D.;	H & H 88;	4
<i>Pinus ponderosa</i> / <i>Symphoricarpos occidentalis</i>	Forest	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	K.D.;	Hansen et al. 95;	3

WOODLAND TYPES (Trees with crowns not usually touching, canopy cover of trees 25 to 60%)

<i>Fraxinus pennsylvanica</i> / <i>Prunus virginiana</i> (same as <i>F. pennsylvanica</i> - (<i>Ulmus americanus</i>) / <i>Prunus virginiana</i> Woody Draw)	Woodland	Deciduous	Cold-deciduous	Natural / Semi-natural	Cold-deciduous	K.D.	H & H 88;	3
<i>Juniperus scopulorum</i> / <i>Artemisia</i> <i>Tridentata</i> ssp. <i>wyomingensis</i>	Woodland	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	S.C. & B.H.	S.W.MT. 95;	3
<i>Juniperus scopulorum</i> / <i>Oryzopsis micrantha</i>	Woodland	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	J.V.	R. D. et al. 95;	3
<i>Pinus ponderosa</i> / <i>Juniperus horizontalis</i>	Woodland	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	J. V.	R. D. et al. 95; D. R. 80;	3
<i>Pinus ponderosa</i> – <i>Quercus macrocarpa</i>	Woodland	Evergreen	Temperate to Subpolar needle-leaved	Natural / Semi-natural	Rounded-crowned	K.D.;	H & A 87;	3
<i>Pinus ponderosa</i> / <i>Pseudotsuga spicata</i>	Woodland	Evergreen	Temperate to subpolar, Needle-leaved	Natural / Semi-Natural	Rounded-crowned	H. & H. 88	H & H 88;	4
<i>Pinus ponderosa</i> / <i>Schizachyrium scoparium</i>	Woodland	Evergreen	Temperate to subpolar, Needle-leaved	Natural / Semi-Natural	Rounded-crowned	J.V.	R. P. et al. 77;	2
<i>Populus deltoides</i> / <i>Symphoricarpos occidentalis</i>	Woodland	Deciduous	Cold-deciduous	Natural / Semi-natural	Temporarily flooded	J.V.	ND, SD, WY	2-3
<i>Quercus macrocarpa</i> / <i>Symphoricarpos occidentalis</i>	Woodland	Deciduous	Cold-deciduous	Natural / Semi-natural	Cold-deciduous	B.H.	H. & A. 87	?
<i>Quercus macrocarpa</i> / <i>Carex inops</i> var. <i>heliophila</i>	Woodland	Deciduous	Cold-deciduous	Natural / Semi-natural	Cold-deciduous	B.H.	J. 92	?

Plant Association/ Community Type	Class	Subclass	Group	Subgroup	Formation	Observers	Literature Citations	G Rank:
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SHRUBLAND TYPES (Shrubs generally > 0.5 m tall and shrub canopy cover > 25%)

<i>Artemisia cana</i> / <i>Pascopyrum smithii</i>	Shrubland	Evergreen	Microphyllous	Natural / Semi-natural	Temporarily flooded	J.V.	H & H 88;	4
<i>A. tridentata</i> ssp. <i>wyomingensis</i> / <i>Pascopyrum smithii</i> (<i>Elymus lanceolatus</i>)	Shrubland	Evergreen	Microphyllous	Natural / Semi-natural	Microphyllous leaved (modifiers not assigned)	J.V.	H & H 88; WY?	4
<i>A. tridentata</i> ssp. <i>wyomingensis</i> / <i>Stipa comata</i>	Shrubland	Evergreen	Microphyllous	Natural / Semi-natural	Microphyllous leaved (modifiers not assigned)	K.D.	D & L 93:	5
<i>Chrysothamnus nauseosus</i> Alliance	Shrubland	Deciduous	Cold deciduous	Natural / Semi-natural	Temperate shrubland	K.D.	Undefined; D & L 93:	?
<i>Crataegus succulenta</i>	Shrubland	Deciduous	Cold deciduous	Natural / Semi-natural	Temporarily flooded	K.D.	Hansen et al. 95	2
<i>Prunus virginiana</i>	Shrubland	Deciduous	Cold deciduous	Natural / Semi-natural	Temperate, cold-decid.	K.D.	Hansen et al. 95	4
<i>Rosa woodsii</i>	Shrubland	Deciduous	Cold deciduous	Natural / Semi-natural	Temporarily flooded	K.D.	Hansen et al. 95	4
<i>Salix exigua</i>	Shrubland	Deciduous	Cold deciduous	Natural / Semi-natural	Temporarily flooded	S.C. & B.H.	Hansen et al. 95	5
<i>Sarcobatus vermiculatus</i> – <i>A. tridentata</i> ssp. <i>wyomingensis</i>	Shrubland	Deciduous	Extremely xeromorphic	Natural / Semi-natural	Intermittently flooded	K.D.	D & L 93;	4
<i>Sarcobatus vermiculatus</i> – <i>Atriplex gardneri</i>	Shrubland	Deciduous	Extremely xeromorphic	Natural / Semi-natural	Intermittently flooded	K.D.	R.D. et al. 95;	4
<i>Shepherdia argentea</i> Alliance	Shrubland	Deciduous	Cold deciduous	Natural / Semi-natural	Temporarily flooded	K.D.	Hansen et al. 95	4
<i>Symphoricarpos occidentalis</i>	Shrubland	Deciduous	Cold deciduous	Natural / Semi-natural	Temporarily flooded	K.D.	H & H 88; Hansen et al. 95	4

DWARF SHRUBLANDS (criteria same as shrublands but, shrubs usually under 0.5 m tall)

<i>Atriplex gardneri</i> / <i>Elymus lanceolatus</i>	Dwarf Shrubland	Evergreen	Extremely xeromorphic	Natural / Semi-natural	Facultatively deciduous	J.V.	R.D et al. 95;	?
<i>Juniperus horizontalis</i> / <i>Carex inops</i>	Dwarf Shrubland	Evergreen	Microphyllous or Needle-leaved	Natural / Semi-natural	Creeping or matted	Literature Cited	Hansen et al. 84;	4
<i>Juniperus horizontalis</i> / <i>Elymus lanceolatus</i> (using <i>Pascopyrum smithii</i> as alt. Indicator)	Dwarf Shrubland	Evergreen	Microphyllous or Needle-leaved	Natural / Semi-natural	Creeping or matted	B.H. & S.C.	R.D. et al. 95;	?
<i>Juniperus horizontalis</i> / <i>Schizachyrium scoparium</i>	Dwarf Shrubland	Evergreen	Microphyllous or Needle-leaved	Natural / Semi-natural	Creeping or matted	B.H. & S.C.	Hansen et al. 84;	4

SPARSE VEGETATION (total vegetation cover, excluding crustose lichens, is generally 1-10%)

<i>Atriplex suckleyi</i> (syn. <i>A. dioica</i>)	Sparse Vegetation	Unconsolidated Material	Soil slopes	Natural / Semi-natural	Dry slopes	B.H & S.C.; J.V.;	No reference	?
<i>Chrysothamnus nauseosus</i> - <i>Eriogonum pauciflorum</i> *	Dwarf Shrubland	Deciduous	Cold-deciduous	Natural / Semi-natural	Caespitose	J.V.	Not described	?
<i>Eriogonum pauciflorum</i> Alliance*	Dwarf Shrubland	Deciduous	Cold-deciduous	Natural / Semi-natural	Caespitose	K.D.	?	?

Plant Association/ Community Type	Class	Subclass	Group	Subgroup	Formation	Observers	Literature Citations	G Rank:
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HERBACEOUS VEGETATION (Graminoids, forbs, ferns and fern allies dominant, generally at least 25% canopy cover; tree & shrubs < 25% canopy cover)

<i>Artemisia longifolia</i> / <i>Oryzopsis hymenoides</i>	Sparse Vegetation	Unconsolidated Material	Soil slopes	Natural / Semi-natural	Dry slopes	J.V.; B.H. & S.C.	R.D. et al. 95	2
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Opuntia polyacantha</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland w/ sparse, needle-leaved or microphyllous evergreen shrub layer	J.V., B.H. & S.C.	WY? Not described	?
<i>Bouteloua gracilis</i> Shortgrass Prairie	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Short sod (including mixed sod & bunch gram.	K.D.	WY	4Q:
<i>Calamovilfa longifolia</i> – <i>Carex filifolia</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland Including sod/mixed grass	B.H. & S.C.	Ross et al. 73;	3
<i>Calamovilfa longifolia</i> – <i>Carex inops</i> ssp. <i>heliophila</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland Including sod/mixed grass	B.H. & S.C.	H & H 88;	3
<i>Carex praeegracilis</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Seasonally flooded	B.H. & S.C.	H, C, & P 88;	?
<i>Chrysothamnus nauseosus</i> / <i>Elymus lanceolatus</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland w/ Sparse, cold-deciduous shrub layer	B.H. & S.C.	Undefined	?
<i>Distichlis spicata</i> var. <i>stricta</i> Inland Saltgrass Saline Prairie	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Temporarily flooded	B.H. & S.C.	R.F.D. 70;	3-5
<i>Eleocharis palustris</i> Wet Meadow (<i>Eleocharis xyridiformis</i> ?)	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Seasonally flooded	B.H. & S.C.	Hansen et al. 95	5
<i>Elymus lanceolatus</i> – <i>Buchloe dactyloides</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland Including sod/mixed grass	B.H. & S.C.	Undefined: see PASSMI – BUCDAC	?
<i>Gutierrezia sarothrae</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland w/ Sparse cold-deciduous shrub layer	K.D.; J.V.	Undefined	?
<i>Juncus balticus</i> Wet Meadow	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Seasonally flooded	B.H. & S.C.	Hansen et al. 95	5
<i>Pascopyrum smithii</i> – <i>Carex filifolia</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland Including sod/mixed grass	B.H. & S.C.	Hansen et al. 95;	4
<i>Pascopyrum smithii</i> – <i>Distichlis spicata</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Temporarily flooded grass	B.H. & S.C. K.D.	WY	4
<i>Pascopyrum smithii</i> - <i>Nasella viridula</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland Including sod/mixed grass	B.H. & S.C.	D. et al. 91	4
<i>Pascopyrum smithii</i> – <i>Poa secunda</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland Including sod/mixed grass	B.H. & S.C.	Undefined	?
<i>Pascopyrum smithii</i> – <i>Stipa comata</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland, sod (including bunch gram.)	K.D.	MB, ND, NE, SD, SK	?
<i>Pseudoroegneria spicata</i> – <i>Carex filifolia</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall bunch grassland	B.H.	H & H 88;	4
<i>Puccinellia nuttalliana</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Temporarily flooded grassland	B.H. & S.C.	B.H. 96	1?

Plant Association/ Community Type	Class	Subclass	Group	Subgroup	Formation	Observers	Literature Citations	G Rank:
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HERBACEOUS VEGETATION (Graminoids, forbs, ferns and fern allies dominant, generally at least 25% canopy cover; tree & shrubs < 25% canopy cover) **Continued**

<i>Rhus trilobata</i> / <i>Pseudoroegneria spicata</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar w/ sparse shrub layer	Natural / Semi-natural	Medium-tall grassland w/ sparse, cold-deciduous shrub layer	K.D.	H & H 88;	N.A.
<i>Rhus trilobata</i> / <i>Schizachyrium scoparium</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar w/ sparse shrub layer	Natural / Semi-natural	Medium-tall grassland w/ sparse, cold-deciduous shrub layer	K.D.	C & S 82;	3
<i>Sarcobatus vermiculatus</i> / <i>Elymus lanceolatus</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar w/ sparse shrub layer	Natural / Semi-natural	Intermittently flooded w/ sparse xeromorphic shrub	J.V., K.D.	H & H 88; Hansen et al. 95	3
<i>Schizachyrium scoparium</i> – <i>Carex filifolia</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland	K.D., S.C. & B.H.	H & H 88;	4
<i>Schizachyrium scoparium</i> – <i>Carex inops</i> ssp. <i>heliophila</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland	K.D.	C & S 82;	3
<i>Schizachyrium scoparium</i> – <i>Muhlenbergia cuspidata</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland	K.D.,	C & S 82;	2
<i>Scirpus acutus</i> (<i>Scirpus validus</i>) Bulrush marsh	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Semi-permanently flooded	S.C. & B.H.	Hansen et al. 95	5
<i>Scirpus maritimus</i> Alkali Bulrush marsh	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Semi-permanently flooded	S.C. & B.H.	Hansen et al. 95	4
<i>Scirpus pungens</i> Bulrush Wet Meadow	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Semi-permanently flooded	S.C. & B.H.	Hansen et al. 95	2-4
<i>Spartina pectinata</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Temporarily flooded	J.V., S.C. & B.H.	Hansen et al. 95	3
<i>Stipa comata</i> – <i>Bouteloua gracilis</i> (same as <i>S. comata</i> – <i>B. gracilis</i> – <i>Carex filifolia</i> from Great Plains Veg. Classification ??)	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland, sod (including bunch gram.)	K.D.	MB, MT, ND, NE, SD, SK, WY;	5
<i>Stipa comata</i> – <i>Carex filifolia</i> (same as <i>S. comata</i> – <i>Bouteloua gracilis</i> – <i>Carex</i> <i>filifolia</i> from Great Plains Veg. Classification ?)	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland, sod (including bunch gram.)	K.D.	H & H 88; MB, MT, ND, NE, SD, SK, WY;	4
<i>Stipa comata</i> – <i>Carex inops</i>	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Medium-tall grassland, sod (including bunch gram.)	Literature Cited	Hansen et al. 95	4
<i>Typha latifolia</i> (including <i>T. angustifolia</i>) [<i>Typha</i> spp. Northern Great Plains Cattail Marsh of Great Plains Veg. Classification]	Herbaceous Vegetation	Perennial Graminoid	Temperate to subpolar grassland	Natural / Semi-natural	Semi-permanently flooded	K.D, J.V.	Hansen et al. 95	5

1. Observer(s): B.H. = Bonnie Heidel, Botanist, MTNHP; J.V. = Jim Vanderhorst, Botanist, MTNHP; K.D. = Keith Dueholm, Contracting Botanist; S.C. = Steve Cooper, Ecologist, MTNHP

2. Literature Citations: C & S 82 = Culwell and Scow 1982; Hansen et al. 95 (see Lit. Cited); H. C. & P. 88 = Hansen et al. 1988; H & H 88 = Hansen and Hoffman 1988; S.W.MT. 95 = Cooper et al. 1995; R.D. et al. 95 = DeVelice et al. 1995; H & A 87 = Hoffman and Alexander 1987; D & L 93 = DeVelice and Lesica 1993; Ross et al. 73 = Ross et al. 1973; R. P. et al. 77 = Pfister et al. 1977; R.F.D 70 = Daubenmire 1970; ND, SD, MN, SK, etc. are states and provinces from which the type has been cited and where literature documenting its occurrence can be expected to be found.

FOREST AND WOODLAND VEGETATION TYPES

Juniperus scopulorum / *Oryzopsis micrantha* Plant Association

(JUNSCO / ORYMIC; Rocky Mountain juniper / little seed ricegrass)

MTNHP rank G3/S3

Environment: This is a localized woodland type that is found in breaklands and badlands topography. It was sampled in one plot on highly dissected shale uplands above Keith Creek, a Powder River tributary in west-central Carter County, where it is confined to moderate to steep slopes with northerly aspects. It is considered a topographic climax type and has been found by Hansen and Hoffman (1988) on similar exposures but with sandstone parent materials on the Custer National Forest, as well as on porcellanite (iscoria; Girard et al. 1988). It is susceptible to fire under any burn regimes. We observed additional stands of JUNSCO/ORYMIC confined to north aspects on BLM land in the badlands and breaklands of northeastern and southeastern Carter County. Hansen and Hoffman (1988) also sampled plots of JUNSCO/ORYMIC in Carter County on the Long Pines unit of the Custer National Forest.

Vegetation: The sampled stand has 80% canopy cover by *Juniperus scopulorum*, forming dense stand conditions with many low, stiff branches. Like virtually all other Rocky Mountain juniper stands, it was logged in the past for fence posts. Moderately high cover (30%) by the palatable bunchgrass *Oryzopsis micrantha*, the absence of the bunchgrass *Agropyron spicatum*, rich forb flora and the nearly closed canopy distinguish this association from other Rocky Mountain juniper types. It has a surprisingly mesic environment for a shale slope. Together with absence of livestock use, there is a relatively high diversity of forbs, including species not found in other local habitats that are indicative of mesic conditions (*Campanula rotundifolia*, *Geum triflorum*, *Maianthemum stellata* and *Heuchera richardsonii*). These same species were also found in stands of JUNSCO/ORYMIC nearby on the Custer National Forest (Hansen and Hoffman 1988). The plot has 20 % combined ground cover of moss and lichen which is accord with Hanson and Hoffman (1988) findings for southeastern Montana and Girard et al. for North Dakota (1988). Despite substrate differences, this stand on shale closely resembles in overall physiognomy and floristics those on the Custer National Forest which are on sandstone. It is also quite similar to stands sampled in northeastern and central Montana (Culwell et al. 1986, DeVelice et al. 1995, Heidel 1996).

The stand has a well-developed undergrowth (about 70% cover) by the low shrub *Mahonia repens*, which Hansen and Hoffman (1988) consider a seral element in this habitat type of the Ashland District where it is accidental or at the edge of the community rather than throughout the interior. This shrub is not found in this plant association in adjoining states. In light of this component and the exceptionally well developed Rocky Mountain flora, the JUNSCO/ORYMIC stands in this area of the state are a priority for more sampling.

Adjacent steeper, more eroded slopes have small patches of *Artemisia longifolia* communities, and warmer aspects are nearly devoid of vegetation. Draw and gully bottoms are dominated by rhizomatous wheatgrass (*Elymus lanceolatus* or *Pascopyrum smithii*). Nearby woodlands have *Juniperus*

scopulorum mixed with *Pinus ponderosa* but the undergrowth layers of these communities are nearly dominated by introduced yellow sweetclover (*Melilotus officinalis*).

Soils: The sampled stand and other observed stands occur on a shale substrate, with a distinct duff layer overlaying the clayey soils. Elsewhere in Carter County JUNSCO/ORYMIC occurs on sandstone derived soils (Hansen and Hoffman 1988). In North Dakota the type occurs on soils with textures ranging from sandy to clay loams (Hansen et al. 1984, Girard 1989).

Sample No.	pH	EC mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV004	16.5	0.11	5	26	69	Clay	-

Comments: Many Rocky Mountain juniper stands in the vicinity of the plot and the plant association elsewhere are on gentler slopes and have a structure that is more open, with undergrowths that have become dominated by sweetclover (*Melilotus officinalis*). The high undergrowth diversity exhibited in the plot may indicate that canopy closure and undergrowth establishment occurred prior to the invasion of sweetclover, or that these other stands are simply less-developed phases outside of the typical setting and more subject to weed invasion. JUNSCO / ORYMIC was provisionally identified as a rare plant community of the northern Great Plains (Faber-Langendoen et al. 1997) because it is not very extensive, and alteration has been widespread.

This plant association has among the highest numbers of vascular plant species and unique vascular plant composition among the plant associations documented. Nonvascular plant diversity appears high and would be interesting to examine. The cover of mosses and lichens is important for retaining soil and stabilizing soil, and is easily disturbed. The dense cover of Rocky Mountain juniper provides game habitat (Girard et al. 1988), including shelter and escape cover.

***Pinus ponderosa* / *Juniperus communis* Plant Association**

PINPON / JUNCOM; ponderosa pine / common juniper

MTNHP rank G4/S3

Environment: The PINPON/JUNCOM is a recurrent forest type of the small BLM holdings on the periphery of the Custer National Forest units in Carter County, though it makes up a small area. Two stands were sampled on BLM parcels on the periphery of the Ekalaka Hills and at the Belltower Butte. Stands are generally ensconced below rimrocks of sandstone capped tablelands, favoring steep (40 % plus) northern aspects, representing small areas with natural firebreaks.

Vegetation: The presence of *Juniperus communis*, a species easily killed by fire, in this plant association is diagnostic (Hansen and Hoffman 1988). Absence of fire scars and development of a thick litter layer are indications of a long fire interval in this community where sampled on BLM in the Ekalaka Hills. In contrast, evidence of past fires is common in stands of the two adjacent forest communities, PINPON/CARINO and PINPON/PRUVIR (Hansen and Hoffman 1988). Ponderosa pine itself is resistant to fire, resistance increasing with tree age and bark thickness.

In the two plots sampled, cover by *Pinus ponderosa* is about 50%. Cover by the dominant shrub *Juniperus communis*, ranges from 20 to 50%. The shrubs *Mahonia repens* and *Prunus virginiana* are also well represented in both plots. Graminoid cover barely exceeds trace amounts, far less than that of shrubs, but includes species (*Carex backii*, *Schizachne purpurascens*) which are not found outside of forest and woodland habitats in Carter County. Forb cover and diversity is also relatively low but includes species (*Maianthemum stellata*, *Disporum trachycarpum*) unique to these relatively mesic forest or woodland habitats

On the tops of the Ekalaka Hills sampled by Hansen and Hoffman (1988), PINPON/JUNCOM occurs on gentle terrain in a mosaic with *Pinus ponderosa*/*Carex inops* (PINPON/CARINO) and various grassland communities. Positions more mesic than that of our sampled plot in the Ekalaka Hills (generally downslope and more ravine-like settings) grade towards *Pinus ponderosa*/*Prunus virginiana* (PINPON/PRUVIR) and drier sites of *Pinus ponderosa*/*Pseudoroegneria spicata* (PINPON/PSESPI). Very limited extents of all four of these ponderosa pine associations occur on BLM land.

Soils: Parent materials are sandstones or sandstones with some admixture of colluvial shale; they have weathered to sandy loams and sandy clay loams. As with most of the forested environments sampled soils are distinctly more acidic than those of rangelands (with exceptions for extraordinary substrates, such as bentonite clays.) These soil parameters are in accord with the values found by Hansen and Hoffman (1988).

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0006	6.8	0.08	48	22	30	Sandy clay loam	-
97JV0008	6.6	0.05	74	17	9	Sandy loam	-

Comments: PINPON/JUNCOM is apparently an uncommon plant association in Montana, known only from Carter County (Hansen and Hoffman 1988) and was not previously documented from BLM land in the state (Cooper and DeVelice 1995). The PINPON/JUNCOM stands documented by Hansen and Hoffman (1988) contained greater than 15% canopy cover of *Carex inops*, which distinguishes them from stands we sampled and casts them as intermediary between PINPON / CARINO and PINPON / JUNCOM. Outside Montana it has only been documented from the Black Hills, South Dakota and Wyoming (Hoffman and Alexander 1987, Thilenius 1972) and from the Bighorn Mountains, Wyoming (Hoffman and Alexander 1976). The type was noted as intensively managed for timber and forage where it occurs on the Custer National Forest in Carter County (Hansen and Hoffman 1988). The stands observed on BLM were untouched by logging, and show little evidence of use by livestock, though deer are abundant. Their occurrence on small isolated BLM tracts in relatively inaccessible positions below the rimrock has perhaps protected them from disturbance. These stands signify well-developed, mature forms of an uncommon vegetation type.

***Pinus ponderosa/Pseudoroegneria spicata* Plant Association**

PINPON/PSEROE; ponderosa pine/bluebunch wheatgrass

MTNHP rank G4/S4

Environment: This is the most xeric and perhaps the most widespread woodland type on BLM-administered lands in Carter County. It is not restricted to a single landform but is recurrent in a variety of broken topography settings, including the margins of escarpments and breaklands, and scattered knolls, particularly on warm, dry slopes with well-drained soils derived from sandstone, porcellanite, and limestone. It is most extensive in the northern end of the county.

Vegetation: This woodland type has open stand structure and conspicuous bunchgrass undergrowth; it is described by Hansen and Hoffman (1988) for southeastern Montana. It is included in this report to provide context for the other ponderosa pine communities, though it was not sampled in study plots.

The PINPON/PSEROE woodland type is present at the perimeter or interstices of most other coniferous woodland types in the county. It is also found apart from them in outlying scattered patches. It is maintained by low-intensity ground fires.

Comments: It would be valuable to circumscribe the full range of vegetation and environmental characteristics of this type on BLM-administered lands.

***Pinus ponderosa* / *Juniperus horizontalis* Community Type**

PINPON / JUNHOR; ponderosa pine / creeping juniper

MTNHP rank G3/S3

Environment: This is a woodland type restricted to one corner of the county, sampled in two plots, and noted only in a small area of arid hills east of Mill Iron in northeastern Carter County. Here it is the predominant woodland type on BLM tracts and occupies slopes, usually with northerly aspects but extending to protected easterly and westerly positions, of the side ridges of dissected sandstone capped tablelands. It has been noted elsewhere in southeastern Montana in similar settings.

Vegetation: The sampled stands have a relatively open canopy (about 30% cover) of relatively small trees (estimated largest trees about 12" dbh, 40 ft. tall) and a low shrub layer clearly dominated by *Juniperus horizontalis* (70-80% cover). It is hypothesized that this ground hugging evergreen shrub becomes established in thinsoil settings, possibly blowouts, and serves as nursery cover for seedlings of *Pinus ponderosa*. This is supported by the many pine seedlings and saplings observed in patches of creeping juniper outside the forest canopy. It is provisionally treated as a community type (successional community) rather than a plant association (climax community) because no mature stands were observed or have been reported of this type, and on-site observations are consistent with succession to other local *Pinus ponderosa* types, e.g., with *Pseudoroegneria spicata* or *Juniperus communis*. Presence of the shrub *Rhus trilobata* in both plots, although only in trace amounts, provides continuity with stands of PINPON/JUNHOR described from northeastern Montana (DeVelice et al. 1995), where this species was constant and sometimes an understory codominant. Cover values of other understory graminoids and forbs are low, composed mostly of species found in neighboring range communities.

Warmer aspect slopes of the side ridges may be occupied by *Schizachyrium scoparium* communities (SCHSCO/CARFIL) which may also be seral to *Pinus ponderosa* communities (also see discussion of PINPON/SCHSCO). The ridge tops are occupied by grasslands (mostly STICOM/CARFIL) on well-drained soils, and sagebrush steppe (ARTTSW/PASSMI) on shallow, poorly drained soils on level bedrock. Alluvial terraces below the ridges are occupied by silver sagebrush communities (ARTCAN/CALLON). More mesic higher elevation stands of ponderosa pine in the vicinity lack *Juniperus horizontalis*. Dusek (1980) described ponderosa pine communities of the Custer National Forest Long Pines unit and noted a PINPON/JUNHOR community type confined to coulee heads and sidehills with very coarse textured soils in the adjacent to the BLM tracts sampled by our plots.

Soils: Within Carter Co. and throughout the eastern-most portion of Montana this type is found on well-drained soils derived from sandstone or sandstone mixed with porcellanite (iscoria), which weather to sandy loams and loams.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0010	6.9	0.10	72	19	9	Sandy loam	-
97JV0016	7.7	0.15	53	32	15	Sandy loam/loam	-

***Pinus ponderosa* / *Schizachyrium scoparium* Community Type**

(syn. *Pinus ponderosa* / *Andropogon scoparius*)

PINPON / SCHSCO; ponderosa pine / little bluestem

MTNHP rank G2/S2

Environment: One plot of PINPON/SCHSCO was sampled on rolling sandstone-capped tablelands in the Ekalaka Hills. Very small stands of this type were noted elsewhere on warm slopes with mostly sandstone-derived, coarse textured substrates with considerable gravel content; often these sites were judged to be highly erosive.

Vegetation: The tree component consists of scattered (ca. 3% canopy cover) young trees about 20 ft. tall. The distinct herbaceous layer is dominated by the bunch-forming, warm season grass, *Schizachyrium scoparium* (syn. *Andropogon scoparius*) with about 20% cover. Other common native graminoids in the plot are the sedge *Carex inops* (syn. *C. heliophila*, *C. pensylvanica*) and the grass *Pascopyrum smithii* (syn. *Agropyron smithii*, *Elymus smithii*), both rhizomatous native species. The rhizomatous, introduced bluegrass, *Poa pratensis* has app. 10% cover. The sedge *Carex filifolia*, which is associated with Carter County little bluestem grassland communities (SCHSCO/CARFIL), was absent in this plot. Forbs are relatively abundant, but most are increasers common in adjacent rangelands; *Artemisia ludoviciana* and *Helianthus rigidus* are the most abundant. A trace of *Yucca glauca* was the only shrub.

Our plot on BLM land is on the edge of stands of *Pinus ponderosa*/*Carex inops* (syn. *C. heliophila*) on the Custer National Forest which were sampled by Hansen and Hoffman (1988). Another forest type on the tablelands, in stands untouched by past fires, is *Pinus ponderosa*/*Juniperus communis*, also sampled by Hansen and Hoffman (1988). Unforested areas of the top are grazed grasslands (STICOM/CARFIL). Similar stands of PINPON/SCHSCO were observed on BLM land in the vicinity of Pine Hill east of Mill Iron. This community type was also noted to occur throughout the Custer National Forest Long Pines (Dusek 1980) where site characteristics were not easily distinguishable from those of *Pinus ponderosa*/*Pseudoroegneria spicata* stands.

Soils: Soils are loamy and well drained.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0009	6.6	0.09	47	38	15	loam	-

Comments: We maintain that this community type, provisionally identified as a rare plant community in the northern Great Plains (Faber-Langendoen et al. 1997), warrants further review as to its rarity as well as its successional status. It is fairly well documented from the Black Hills in Wyoming (Jones 1992) and South Dakota (Thilenius 1972), and in the Little Missouri, Powder, and Tongue River drainages in southeastern Montana (Pfister et al. 1977). It may have a broad distribution extending south to New Mexico and east to Nebraska (Faber-Langendoen et al. 1997).

Our sampled stand appears to be a seral community, consistent with the interpretation of Hansen and Hoffman (1988). They hypothesized that PINPON/SCHSCO communities become established in SCHSCO-CARFIL stands where pine has been previously eliminated by fire that succeed to other *Pinus ponderosa* habitat types. The presence of *Carex inops* in our plot, and composition of adjacent mature *Pinus ponderosa* stands indicate possible progression towards PINPON/CARHEL.

In contrast, this type has been observed elsewhere in southeastern Montana on warm, dry sites that are not seral to PINPON/CARINO. Wyoming examples of this type have been documented as having relatively dense tree canopies (Jones 1992) and appreciable coverage of *S. scoparium*, which would argue for considering these stands as long-term-stable communities and not seral representations of other types.

***Populus deltoides* / *Symphoricarpos occidentalis* Community Type**

POPDEL / SYMOCC; plains cottonwood / western snowberry

MTNHP rank: G2G3/S?

Environment: Cottonwood stands are found on alluvial bottoms, and there are few of these setting for cottonwood communities on BLM land in Carter County. The possible exceptions are small holdings along the Little Missouri River and lower Cottonwood Creek, which were not surveyed. Most riparian zones along the larger watercourses are private property and cottonwoods along smaller watercourses are scattered or comprise a very narrow corridor without distinctive woodland community structure. In addition, these habitats are usually altered in their vegetation. One small stand of POPDEL/SYMOCC in relatively good condition was located and sampled on BLM along North Cottonwood Creek. Fencing is in place, and the stand appears to be far less impacted by livestock compared to surrounding habitat. It is located on a floodplain with a meandering stream and is probably both seasonally inundated and subirrigated; higher terraces and surrounding low relief rolling uplands are occupied mostly by sagebrush steppe (ARTTSW/ELYLAN) and grasslands (ELYLAN/STIVIR).

Vegetation: *Populus deltoides* is the only tree present in the sampled stand. Trees are large and provide a tall canopy with about 50% cover. The shrub layer is about 1 m tall and provides nearly complete cover, mostly by *Symphoricarpos occidentalis*, but *Rosa arkansana* is also common. Two rhizomatous grasses are well represented, the native *Pascopyrum smithii* (tall, with wide glaucous leaves in this mesic habitat), and the exotic *Poa pratensis*. Forb cover is also significant with exotic species (*Cirsium arvense*, *Medicago lupulina*, *Medicago sativa*, *Taraxacum officinale*, *Tragopogon dubius*) prominent, but the highest cover is attained by the natives *Aster falcatus* and *Ratibida columnifera*.

Cottonwood stands are seral (community type), becoming established in response to deposition by shifting stream channels. They normally do not regenerate at the same spot except as exposed river channels adjoin the stand. Hansen et al. (1995) described POPDEL/SYMOCC as a grazing induced secondary seral stage of the mid-seral POPDEL/CORSTO community type, but in Wyoming, the type was seen as indicative of low levels of grazing (Thilenius et al. 1995). Hansen et al. (1995) report the latter from narrow bands on the Little Missouri River in the county, where it probably depends on stable soil moisture. Exclusion of cattle from our sampled stand appears to have preserved or allowed reestablishment of high cover by shrubs, but there is no evidence of progression towards POPDEL/CORSTO or any particular climax type (there are not shrubs of *Cornus stolonifera* or tree species besides *Populus deltoides* in the vicinity).

Comments: POPDEL/SYMOCC is considered a rare plant community (G2G3) as it occurs in Wyoming, western South Dakota, and western North Dakota (Faber-Langendoen et al. 1997). In central and eastern Montana, Hansen et al. (1995) characterize it as a major low-elevation seral community type of older alluvial bars and terraces. The discrepancy may be attributable to Hansen et al. (1995) not weighing the condition of the stands and the ongoing threats to their composition. Hansen et al (1995) speculate POPDEL / SYMOCC is a grazing-induced form of POPDEL / CORSTO (wherein the tall shrubs have been eliminated). Our sampled stand is similar floristically to 8 stands sampled in eastern Wyoming (Thilenius et al. 1995) in the importance value of *Pascopyrum smithii* (well represented in our plot,

constant in theirs), but differs in composition of native forbs (they describe an abundance of *Maianthemum stellatum* in ungrazed habitat). The eighteen stands sampled by Hansen et al. (1995) in Montana are more variable; only *Populus deltoides* is 100 % constant. The successional sequence envisioned by Hansen et al. (1995) in the absence of sediment deposition includes development of a lush, tall shrub layer characteristic of stands of POPDEL / *Cornus stolonifera* followed by the *Fraxinus pennsylvanica* / *Prunus virginiana* or *Acer negundo* / *Prunus virginiana* plant associations (depending on seed sources). The development of these later or potential natural community stages as Hansen et al. (1995) envisage for POPDEL/SYMOCC in Montana may be geomorphically, (climatically) or topographically limited. This plant association also corresponds with the major subtype of the Cottonwood community documented in southwestern North Dakota (Wali et al. 1980) which has a distinct tall shrub component that includes *Shepherdia argentea*, *Rosa woodsii* and *Salix amygdaloides*. We interpret their absence in the sample plot to reflect the increased aridity of the climate, perhaps a drier western phase. Management of the sample stand as an exclosure could provide answers to questions concerning management and classification of POPDEL/SYMOCC in Carter County. Further survey for and sampling of this and other cottonwood community types in Carter County on BLM lands is identified as a tentative priority.

***Quercus macrocarpa*/ *Carex inops* ssp. *heliophila* Plant Association**

QUEMAC / CARINO; bur oak / sun sedge

MTNHP rank: G1Q/ S1

Environment: A single stand of QUEMAC/CARINO was sampled on BLM land on north aspect toeslopes of a Mowry Shale ridge just north of the Wyoming border. This is the primary bur oak-dominated community type in the area, encompassing most of Montana's only population of bur oak (*Quercus macrocarpa*). It is restricted to the two parallel shale ridges that represent the only outcrops of Mowry Shale in the state. The ridges lie within an area that is less than 2 miles x 9 miles in area. Bentonitic shale is extensively exposed, and its high shrink-swell capacity gives the soil surface a fractured appearance through dry summer months. The ridges rise about 50 m (150 ft) above the surrounding plains with variable slopes across the broken topography, and this plant association prevails across the side slopes of the ridges, thinning out on top.

Vegetation: Except for discrete openings, these woodlands have a fairly dense canopy of short stature (about 20 ft. tall) trees, including about 60% cover by bur oak (*Quercus macrocarpa*) and variable cover (average about 20%) by Rocky mountain juniper (*Juniperus scopulorum*). The shrub layer is depauperate, but *Ribes setosum* is well represented in patches (10% total cover in the plot) confined to canopy projections of oak trees. Grasses and sedges comprise the well-developed herbaceous layer with about 30% total cover; most abundant are sun sedge (*Carex inops* ssp. *heliophila*) a native rhizomatous sedge with about 10% cover, and major but variable cover by Kentucky bluegrass (*Poa pratensis*), an exotic rhizomatous grass with about 20% cover. Cover by forbs is relatively low (about 10%) while forb diversity is relatively high (18 species in the plot). Of these there is a high proportion of annuals, both native and exotic (*Collinsia parviflora*, *Collomia linearis*, *Ellysia nyctelea*, *Galium aparine*, *Lotus unifolius*, *Parietaria pennsylvanica*, *Polygonum convulvulus*, *Polygonum douglasii*, *Thlaspi arvense*), probably reflecting the cool, wet growing season of 1997. This community type had the highest diversity of fungi observed in Carter County.

On the broken ridgetops, there is increased cover of ponderosa pine (*Pinus ponderosa*) to the point of becoming a codominant tree species. On the more sheltered north-facing slopes, Rocky Mountain juniper (*Juniperus scopulorum*) approaches codominance. Openings in the toeslope woodlands are alluvial washes dominated by *Carex inops* ssp. *heliophila* (syn. *C. heliophila*; *C. pennsylvanica*) and *Calamovilfa longifolia* (see discussion of CALLON / CARINO). The open ridgetops are similarly dominated by sun sedge, and the widely spaced oaks at the margins presents a savanna-like ecotone. Upland community types in the inter-ridge basins are predominantly sagebrush steppe (ARTTSW/ ELYLAN) and wetland bottoms (headwaters of Sheldon Creek) have *Spartina pectinata* communities (SPAPEC).

This deciduous woodland type is incompletely documented in the literature and addressed in state classifications. It is reported in South Dakota (Hoffman and Alexander 1987) and in Wyoming (Jones 1992); the Wyoming records are directly contiguous with the study area. Associated species in the Wyoming characterization include, beside the dominants: blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), western wheatgrass (*Pascopyrum smithii*), native bluegrass (probably *Poa secunda* and *P. ampla*), prairie sandreed (*Calamovilfa longifolia*), sagewort (*Artemisia ludoviciana*), and prickly pear (*Opuntia polyacantha*). It is also noted that exotic annual weeds may obscure the native species. It is characterized as open woodland with oak over from less than 25% - about 60%.

This community type is geographically restricted, barely entering Montana. It has not been previously described in the state, but it has been characterized for adjoining Wyoming (Jones 1992). A similar type with *Pinus ponderosa* codominant with *Quercus macrocarpa* and *Juniperus scopulorum* in about equal proportions was sampled by three plots nearby in Montana on the same ridge system (Ecological Consulting Service 1975). That study identified the wetland sedge, *Carex viridula*, as an important understory element in the plots, but this is a likely misidentification of *Carex inops*. There is a need for further sampling to sort whether there are one or two plant associations of oak on the Alzada shale ridges.

Note: Bur oak forest and woodland plant associations are found in the Black Hills (Hoffman and Alexander 1987), and this study area represent the northern extremity of the Black Hills ecoregion. However, the QUEMAC/CARINO plant association is compositionally different from Black Hills oak communities and the environment is edaphically distinct.

Soils: The relatively high proportion of the sand fraction (38%) indicates that soils have not been derived from shale alone but are probably influenced by lenses of sandstone. Soil reaction is distinctly acidic as is known for some marine shales.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0020	5.2	-	38	27	35	clay loam	4.94

Comments: This area of shale ridges has been extensively altered by bentonite mining, associated haul roads, and grazing by sheep and cattle. Nevertheless, it is part of the westernmost stand in the continent. Tree genetics research shows that bur oak in the Black Hills shows some attributes of *Quercus Gary*, a southwestern oak species.

BLM tracts represent the only portion of the Montana stands on public lands administered by agencies with sensitive species or natural areas programs. The BLM-administered tracts within the Alzada Oaks are said to have been withdrawn from ACEC consideration (Vosen pers. commun.), and land exchanges for high quality oak stands have not been considered to date. We recommend exchanging information with Wyoming to determine if there are any stands documented without exotic annual species, and if there is a mitigation need to conserve this threatened plant association.

***Quercus macrocarpa* / *Symphoricarpos occidentalis* Plant Association**

QUEMAC / SYMOCC; bur oak / western snowberry

MTNHP rank: G? S1

Environment: This community type is documented solely on alluvial terraces of Arkansas Creek, a Little Missouri River tributary, representing a small valley and a subirrigated site on open plains. It is the only report of it in Montana, where it occurs on a scattered BLM tract about 1 mile south of Alzada and 1 mile north of the Wyoming border. Its extent beyond BLM-administered lands is unknown.

Vegetation: One plot of this post-settlement community type was sampled. The stand has a relatively open savanna-like tree canopy dominated by bur oak (*Quercus macrocarpa*) with about 30% cover; intermixed with lesser amounts of green ash (*Fraxinus pennsylvanica*) with about 10% cover. The largest oak trees in the plot are about 30 ft. tall, with 12" diameter at breast height (DBH). Heidel (1993) bored the largest tree found in this stand (18" DBH) and estimated its age to be about 110 years, dating to pre-settlement times. Sexual reproduction by oak appears to be limited; only one seedling was found in the plot, acorn production was poor in 1993 (MTNHP Element Occurrence Record), and no acorns were seen in 1997. *Fraxinus pennsylvanica* trees in the plot are smaller (about 15 ft. tall), but reproduce more successfully; several seedlings were found in the plot. The most abundant native understory species is the western snowberry (*Symphoricarpos occidentalis*) with about 20% cover. Although the placement of the plot was chosen to represent maximum diversity of native species in the stand, the entire area is dominated by a dense sward of introduced grasses. Smooth brome (*Bromus inermis*) is most abundant with about 60% cover, and quack grass (*Elytrigia repens*; syn. *Agropyron repens*), timothy (*Phleum pratense*), and Kentucky bluegrass (*Poa pratense*) are well represented with about 10% cover each. Native graminoids found in lesser amounts in the plot include the sedge *Carex tenera*, and thick-spiked wheatgrass (*Elymus lanceolatus*). Forbs in the plot are mostly exotic species, the most abundant being *Rumex crispus*.

This stand occurs among a mosaic of woodlands dominated by green ash (*Fraxinus pennsylvanica*) and cultivated hay meadows. Older terraces and surrounding rolling uplands are occupied mostly by greasewood and sagebrush communities (SARVER/ARTTSW and ARTTSW/ELYLAN). The shale ridge system to the southeast, which extends into Wyoming, supports upland juniper, bur oak, and ponderosa pine woodlands (see discussion of QUEMAC/JUNSCO).

Soils: The alluvial soils in this reach of the Little Missouri River are derived from Cretaceous shales and are dominated by the clay fraction. The high organic matter content of the upper horizon is indicative of a relatively productive site, which is confirmed by the sward of knee-high introduced grasses.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0023	7.4	-	4	27	69	Clay	4.32

Comments: The closest locations at which the *Quercus macrocarpa*/*Symphoricarpos occidentalis* habitat type have been documented come from the Black Hills of South Dakota and Wyoming (Hoffman and Alexander 1987) at higher elevations. Farther east, the *Quercus macrocarpa*/*Symphoricarpos occidentalis* plant association is sporadic in hardwood draws and breaks above the Missouri River of North Dakota and South Dakota.

This association has a drastically different composition and setting from the oak communities on the shale ridges only a couple miles away. It is mesic by comparison, though not as mesic as the well-developed *Quercus macrocarpa/Ostrya virginiana* p.a. in the Black Hills (Hoffman and Alexander 1987) and the *Quercus macrocarpa/Corylus cornuta* plant association in a few areas of southwestern North Dakota downstream near the Little Missouri River (Girard et al. 1988).

It is consistent that the sole Montana collection of the wild lily-of-the-valley (*Maianthemum canadense*) was collected in 1948 from nearby this locality. Its habitat was described as rich soil in deep woods (Booth 1950), and this species is known from oak stands in adjoining states.

SHRUB- and DWARF SHRUB-DOMINATED VEGETATION TYPES

Artemisia cana / *Pascopyrum smithii* Plant Association (ARTCAN / PASSMI; silver sagebrush / western wheatgrass) MTNHP rank: G4/S4

Environment: This habitat type occurs on level to gently sloping alluvial terraces receiving surface runoff, and on sandy upland slopes in water collecting positions. It is usually restricted to overflow range sites and is frequent on BLM land in the northwest and southwest corners of the county. It is a relatively dry form of riparian habitat (Hanson et al. 1995). Two plots were sampled as representative of native vegetation, and many more stands were observed with heavy invasion by exotic species. The two plots were in close proximity in the vicinity of Newberry Knob at the north end of the Chalk Buttes.

Vegetation: The dominant *Artemisia cana* is the only well represented shrub in the study area plots with about 20% cover, a reduced value compared to the type as reported elsewhere (DeVelice et al. 1995, Hansen et al. 1984, Hansen and Hoffman 1988, Hansen et al. 1995). The herbaceous layer is dominated by grasses with *Pascopyrum smithii* (syn. *Agropyron smithii*, *Elymus smithii*) having about 20-30% cover, again low compared to other studies, and *Stipa viridula* having about 3-10% cover. The sedge *Carex filifolia* is present in both plots and well represented in the plot on an upland slope. The exotic grasses *Poa pratensis* and *Bromus japonicus* are present to varying amounts in the plots. In contrast to other studies, our plots have relatively high diversity and cover by forbs. Constant in both plots are *Achillea millefolium*, *Artemisia ludoviciana*, *Echinacea angustifolia*, *Orthocarpus luteus*, *Psoralea argophylla*, *P. esculenta*, *Ratibida columnifera*, *Tragopogon dubius* and *Zigadenus venenosus*.

Vegetation types on adjacent dryer, upland slopes include *Pinus ponderosa* forests (PINPON/JUNCOM) and grasslands (STICOM/CARFIL). Vegetation in adjacent wetter positions of draws and shaded terrace bottom include woodlands of *Fraxinus pennsylvanica* and thickets of *Symphoricarpos occidentalis*, *Crataegus succulenta*, and *Shepherdia argentea*. Hansen and Hoffman (1988) sampled three stands of ARTCAN/PASSMI in Carter County in the Long Pines unit of the Custer National Forest.

Soils: Stands of ARTCAN/PASSMI are most extensive in Carter County on coarse textured alluvial soils. Soil profiles are poorly developed. In areas lacking upland sandstone outcrops, similar lowland positions are usually occupied by grasslands (ELYLAN), big sagebrush (ARTTSW/ELYLAN), or greasewood (SARVER/ELYLAN) communities. In northeastern Montana (Branson et al. 1970) found total moisture stress was less for coarse textured soils supporting ARTCAN/PASSMI than for finer textured soils of nearby stands of ARTTRI/PASSMI.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0007	7.7	0.12	31	32	37	clay loam	2.32
97JV0042	7.5	0.07	4	32	64	Clay	2.32

Comments: Although the plots represent the best condition stands of ARTCAN/PASSMI observed in the study area, the relatively low cover by grasses and abundance of exotic and increaser species may reflect the influence of cattle grazing. Stands in poorer condition have even lower cover by *Pascopyrum smithii* and increased cover by *Bromus japonicus* and/or *B. tectorum*.

***Artemisia tridentata* ssp. *wyomingensis* / *Pascopyrum smithii*
(*Elymus lanceolatus*) Plant Association**

(syn. *Artemisia tridentata* ssp. *wyomingensis* / *Agropyron smithii* (*Agropyron dasystachyum*)
ARTTSW / PASSMI (ELYLAN); Wyoming big sagebrush / thick-spiked (western) wheatgrass
MTNHP rank: G4/S?

Environment: This sagebrush steppe type is probably the single most extensive plant community in Carter County and is especially abundant on BLM lands. It is the dominant vegetation, often extending uninterrupted for miles, in areas with soils derived from shale. It is a major vegetation type on shale ridge systems, particularly northerly slopes, which are less dissected than southerly aspects and have better developed soils. It represents clayey and shallow clay range sites in these settings. It occurs as the predominant shrubland association on alluvial terraces in areas of shale-derived soils, where it replaces ARTCAN/PASSMI as subirrigated range sites, and it is also found in areas associated with sandstone outcrops or at least coarser-textured soils (silt loams and loams) as shallow range sites. It also occurs in smaller shallow range site patches on sandstone mesa tops in areas with poorly drained shallow soils perched on level bedrock.

Vegetation: Wyoming big sagebrush is well represented and there is an undergrowth dominated by thick-spiked wheatgrass (*Elymus lanceolatus*) and/or western wheatgrass (*Pascopyrum smithii*). Note: The common upland big sagebrush of Carter County is *Artemisia tridentata* ssp. *wyomingensis*, which is distinguished from other subspecies of big sagebrush by its low stature (< 5 dm tall) and by its relatively short (mostly < 12 mm long) persistent leaves which have incurved (convex) margins (Dorn 1992, Tart 1996). We expect that the dominant rhizomatous wheatgrass of most Carter County big sagebrush communities, at least those in the south on heavy clay soils, is *Elymus lanceolatus* (syn. *Agropyron dasystachyum*), however, *Pascopyrum smithii* (syn. *Agropyron smithii*) may grow intermixed or be the dominant grass at some sites. We have chosen to include communities with either grass dominant in the same plant association, due to the difficulty of distinguishing the two species, the possibility of hybridization (Great Plains Flora Association 1986), and their apparently overlapping ecological distributions. We refer to the ARTTSW/PASSMI type by the more widely recognized name pending taxonomic and community classification review.

Six plots were sampled prior to livestock grazing of the season and judged to be in range conditions varying from good to excellent (ungrazed for 12 or more years) to moderately grazed in recent past years. Cover by *Artemisia tridentata* ssp. *wyomingensis* ranged from 10 to 25%. Stands with higher sagebrush cover were observed and fenceline contrasts indicate progression towards higher shrub cover with increased grazing. The shrubs *Artemisia frigida* and *Chrysothamnus nauseosus* have greater than 50% constancy in the plots. Cover by *Elymus lanceolatus*, the dominant grass identified in six plots, ranged from about 10% to 60%. *Pascopyrum smithii* was identified as the dominant grass with about 50% cover in one plot (plot 14 on a poorly drained position of upland sandstone mesa near Pine Hill in northern Carter County). These two species were not distinguished within plots. A particular previous vegetation study in southern Carter County is Thompson Creek drainage (Ecological Consulting Service 1975) found both *Elymus lanceolatus* and *Pascopyrum smithii* in plots of big sagebrush habitat types. In contrast, other studies in the same drainage (MacCracken, et al. 1983, Sieg et al. 1983) identified *Pascopyrum smithii* but not *Elymus lanceolatus* in plots placed in sagebrush communities.

The grass *Koeleria macrantha* is 100 % constant in our plots. The grasses *Poa secunda* and *Stipa viridula* have greater than 50% constancy, though *S. viridula* did not occur in greater than trace amounts. Although an attempt was made to sample stands in good condition, the annual exotic grass *Bromus japonicus* was found in all but one plot; in degraded examples of the type this weed often surpasses *Elymus lanceolatus* or *Pascopyrum smithii* in cover. Cover and diversity of forbs is quite low; *Achillea millefolium*, which occurred in all but one plot, is the only forb with higher than 50% constancy. The soil lichen, *Parmelia chlorochroa*, which is favored by grazing (MacCracken, Alexander, and Uresk 1983), occurred in all but one plot.

Adjacent plant communities are primarily grasslands, most commonly dominated by *Elymus lanceolatus*, but also include shrublands dominated by *Sarcobatus vermiculatus*. There are all degrees of ecotone width, though often it is broad (> 30 ft.) between these shrub-dominated and grass-dominated sites with no obvious difference in controlling variables. Fire and herbicide spraying generally create abrupt ecotones but evidence of fire is difficult to spot when fires burn hot and consume all shrub biomass to the point of dishing out the stem base to below the ground line (occurs in years of high biomass/fuels production). *A. tridentata* ssp. *wyomingensis* has been noted as being strongly positively associated with medium to heavy soils in southeastern Montana and the Dakotas and absent on coarse-textured soils (Johnson 1979) however, our limited soils data show complete overlap of *E. lanceolatus*- (or *Pascopyrum smithii*) dominated communities with ARTTSW/ELYLAN, so far as textural class is concerned.

Soils: Parent materials are principally shales and mudstones but this community type occurs as well on alluvium and sandstone, if there is a compensating factor such as shallow depth to bedrock, which perches water within reach of grass roots. Soil reaction is consistently mildly basic (exception plot 19) and conductivities are mostly low with the exception of plots 27 and 38 ; there is no ready explanation for these anomalous values. Soil texture is typically heavy with the silty clay class probably predominant but sandstones will weather to loams and silt loams.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0004	7.5	0.09	9	43	48	silty clay	3.22
97JV0045	7.9	0.42	-	-	-	-	-
97JV0014	7.3	0.07	10	40	50	silty clay	-
97JV0019	4.9	0.10	1	24	75	clay	1.05
97JV0027	7.7	1.83	-	-	-	-	-
97JV0038	8.0	2.11	16	80	4	silt loam/silt	1.38
97JV0045	7.7	0.17	-	-	-	-	-

Comments: It is possible that the potential vegetation type for many of the alluvial sites supporting this association is actually ARTTSW/ELYLAN-NASVIR but that concentrated livestock use reduced the high canopy cover of *Nasella viridula* (syn. *Stipa viridula*). Although this plant association is abundant in Carter County, it has never been described from eastern Montana under the name here assigned, which specifies a combination of subspecies of sagebrush with potential for dominance by *Elymus lanceolatus* as well as *Pascopyrum smithii*. Cooper et al. (1995) described an *A. tridentata* ssp. *tridentata* / *Pascopyrum smithii* community confined to alluvial fans and terraces in southwestern Montana which has a remarkable floristic similarity to our ARTTSW / ELYLAN (PASSMI) plots. Heidel (1996) described an *A. tridentata* ssp. *wyomingensis*/*Pascopyrum smithii* type on upland breaks above the Missouri River in Fergus County (Heidel 1996). However, our plots for this type in southeastern Montana have a much

broader distribution across the landscape. The differences in habitat occupied are reflected in the differing subspecies of big sagebrush. An *Artemisia tridentata*/*Elymus lanceolatus* habitat type occupying shale derived clay soils was described from the Yellow Triangle of Montana (Jorgensen 1979); both *Elymus lanceolatus* and *Pascopyrum smithii* were indicated dominants, and, in contrast to our plots, *Pseudoroegneria spicata* was common. Our plots of ARTTSW/PASSMI resemble, in most respects, descriptions of *Artemisia tridentata*/*Pascopyrum smithii* (ARTTRI/PASSMI) in the literature, and may be best considered a local variation of that type. Numerous studies have documented ARTTRI/PASSMI communities from eastern Montana (Culwell and Scow 1982, Culwell et al. 1986, DeVelice et al. 1995, Hansen and Hoffman 1988, Northern Energy Resources Co. 1979, Olson-Elliott and Associates 1980), western North Dakota (Hansen et al. 1984, Jensen et al. 1992), and eastern Wyoming (Thilenius et al. 1995). The study by Jensen et al. (1992) designates *Artemisia tridentata* ssp. *wyomingensis* as the dominant shrub in their type from western North Dakota. The ecological significance of big sagebrush subspecies is demonstrated by differences between *Artemisia tridentata* ssp. *wyomingensis*/*Pascopyrum smithii* communities (including our ARTTSW/ELYLAN) in eastern Montana, which are climax plant associations usually occupying upland positions. They contrast with *Artemisia tridentata* ssp. *tridentata* / *Pascopyrum smithii* communities of southwestern Montana, most of which are thought to be grazing disclimaxes and are confined to alluvial terraces (Cooper et al. 1995).

Although vast acreages of ARTTSW/ELYLAN (PASSMI) in Carter County are severely impacted by grazing, there are also large tracts of the community in good to excellent condition, especially in remote locations. Changing demographics may be partially responsible for the abandonment of remote rangelands, and their resulting recovery from past overgrazing. We have noted in the field (locations usually remote or long rested from grazing), sampled one plot (JV0045) and observed in the stand tables of Hansen and Hoffman (1988) and Jensen et al. (1992) that some stands have higher cover (usually exceeding 5%) of *Nasella viridula* (*Stipa viridula*), concomitantly reduced coverages of *Bouteloua gracilis* and soils that are slightly coarser textured (primarily loams) than the sites which support modal examples of ARTTSW / ELYLAN (PASSMI). It should be noted both studies cited above document the potential natural community type of ARTTSW / AGRSMI with exclosure sites or sites long-rested from grazing. Jensen et al. (1992) document that in grazing-impacted seral stages of ARTTSW / AGRSMI the cover of *Stipa comata* and *B. gracilis* increases, that of *P. smithii* decreases and *N. viridula* sharply decreases and eventually is extinguished. We suggest that quite possibly, on lighter-textured soils, such as silty alluvium, or on moister positions, a plant association distinct from ARTTSW / PASSMI (ELYLAN) be recognized as *A. tridentata* ssp. *wyomingensis* / *P. smithii* ñ *Nasella viridula*. Within our study area so much of the landscape has been grazing-impacted it is difficult to ascertain whether the any particular stand supporting higher cover of *N. viridula* reflects a condition of reduced grazing-impact or less stressful conditions in regard to soil moisture. We have kept one plot separate in the Constancy/Cover Appendix (A) that has appreciable cover of *N. viridula* (column heading ARTTSW / PASM-NAVI) so that it may be compared to the modal condition for this type (ARTTSW / PASM (ELLA)).

***Artemisia tridentata* ssp. *wyomingensis* / *Opuntia polyacantha* Community Type**

ARTTSW / OPUPOL; Wyoming big sagebrush / prickly-pear cactus

MTNHP rank: to be determined

Environment: This highly localized community type occurs on nearly level valley floors and benches on erodible alluvial outwash materials weathered from shale. It was sampled by two plots and observed elsewhere numerous times in the course of reconnaissance, and has not been described. It occurs as small patches (<< 1 acre) in matrices of sagebrush steppe (ARTTSW / PASSMI) with higher grass cover, and in grasslands (*Pascopyrum smithii* or *Elymus lanceolatus*-dominated) which occupy less eroded substrates. Additional examination of the soil profile is needed to determine whether these settings represent pan spot range sites, often referred to as iscablands.†

Vegetation: The overall sparse canopy cover is dominated by *Artemisia tridentata* ssp. *wyomingensis* (15-25 %) with a stature considerably shorter (0.15-0.25 m.) than specimens of the surrounding matrix communities (mostly 0.3-0.6 m). There are only eight other species in the two plots, of these, the grass *Elymus lanceolatus*, the forb *Polygonum ramosissimum*, and the cactus *Opuntia polyacantha* are constant. The relative paucity of *E. lanceolatus* in these sites (not exceeding trace amounts) compared to its canopy cover in the surrounding matrix is significant. *Opuntia polyacantha* has 10% cover in one plot, but much higher cover values were noted during reconnaissance. These cursory observations, though not supported by quantitative data, do express a consistency of structure with widely-spaced, short stature *A. tridentata* ssp. *wyomingensis* and the high constancy, if not forb-layer dominance, of *O. polyacantha*; in many instances *Poa secunda* and/or *P. cusickii* are noted to be the herb-layer dominants.

Soils: The depauperate vegetation is reflected in the lack of litter and more than 80% exposed soil surface. Parent materials are alluvial outwash derived from shales. We have inadequate data to compare this community type to its closest analogue, ARTTSW / ELYLAN-BOUGRA but a cursory examination shows a complete overlap in ranges for all variables. Branson et al. (1970) note a *A. tridentata* / *O. polyacantha* community type in northeastern Montana developed on Bearpaw Shale. It differs from a community type they call simply *A. tridentata* by having higher pH values (all over 7 versus all less than 5) and higher soluble sodium values (> 50% versus < 50% soluble sodium).

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0051	8.2	0.21	18	42	40	silty clay	0.86
97JV0052	7.5	0.08	14	49	37	silty clay loam	1.23

Comments: Only Branson et al. (1970) have described (or at least named) an *A. tridentata* / *O. polyacantha* community type, which occurs on Bearpaw Shale in northeastern Montana. The *Artemisia* subspecies they encountered is undoubtedly *wyomingensis* as it is the only subspecies distributed in this corner of Montana (Shultz 1984). They list *Elymus lanceolatus* as having as high a coverage in ARTTSW

/OPUPOL as in the ARTTSW community type. Not knowing the grazing history of their site it is difficult to assess the ecological meaning of the closely comparable graminoid coverages between the two community types. But, these communities are compositionally discriminated by the relatively high *O. polyacantha* cover that is associated with the community type (ARTTSW / OPUPOL) experiencing significantly greater soil moisture stress (combination of matric and osmotic stress).

***Atriplex gardneri* / *Elymus lanceolatus* Plant Association**
 ATRGAR / ELYLAN; (syn. *A. nuttallii* / *Agropyron dasystachyum*);
 Gardner's saltsage / thick-spiked wheatgrass
 MTNHP rank: to be determined

Environment: This is a distinctive community type which occupies relatively large areas on eroded, low relief bentonite/shale ridge systems in southern Carter County. They represent salt-affected upland range sites. It is mostly confined to ridgetops and southerly exposed side ridges and convex slopes. ATRGAR/ ELYLAN was sampled by three plots on BLM land in the Cottonwood Creek drainage (North Fork and Duncan Creek). Patches dominated by *Atriplex gardneri* were also observed on Carter County BLM on steep south facing shale slopes in the breaklands in the southeast corner of the county (Wymonkota).

Vegetation: These highly erodable, sparsely vegetated sites are dominated by the low, mound-forming shrub *Atriplex gardneri* (syn. *A. nuttallii*). This species is salt and drought tolerant (Branson et al. 1970). While the landscape superficially appears barren, we recorded shrub cover values ranging from 30-50% canopy cover. Sometimes the shrubs grow in rows between shallow erosion gullies giving the community a distinctive vertically striped pattern visible from a distance. The grass component is sparse (up to about 10% cover) and patchy, dominated in our plots by *Elymus lanceolatus* (syn. *Agropyron dasystachyum*) and *Elymus elymoides* (syn. *Sitanion hystrix*). There is low diversity of and only trace cover by forbs in the plots, but one plot included two species that were formerly Montana Species of Special Concern that are of biogeographical interest. *Haplopappus multicaulis* and *Xylorhiza glabriuscula*, the former which is a regional endemic to this area of the Great Plains, and the latter which is a Great Basin species at its northern limits.

Downslope gully bottoms and lower slopes with better-developed soils are occupied by grasslands (PASSMI and PASSMI / STIVIR) and further downslope alluvial plains are occupied by greasewood communities (SARVER / ELYLAN). Northerly aspects of these ridge systems are less eroded and less dissected and support sagebrush steppe (ARTTSW/PASSMI).

Soils: Branson et al. (1970) characterized shale-derived soils supporting *Atriplex gardneri* communities in northeastern Montana as having high soluble salt and sodium content, high total moisture stress, and low infiltration rates. Derived primarily from bentonite (sedimentary deposits of montmorillonitic mineralogy (clay texture) resulting from in-place weathering of volcanic ash), study area soils have a high shrink-swell capacity and once wet, a very low permeability. Low infiltration rates result in extensive and intensive sheet, rill, and gully erosion and almost no profile development. The high, but less than 8.5 pH values, and electrical conductivities less than 4 mmhos/cm indicate, respectively, a high sodium content and, technically speaking, a non-saline condition, though values are approaching saline.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0031	7.9	2.80	3	33	64	clay	1.12
97JV0043	8.2	3.64	4	21	75	clay	
97JV0047	8.0	3.27	4	16	80	clay	

Comments: DeVelice et al. (1995) described an ATRGAR / perennial grass community type from northeastern Montana, which they tentatively split into three community types with differing dominant grasses, *Pascopyrum smithii* (syn. *Agropyron smithii*), *Pseudoroegneria spicata* (syn. *Agropyron spicatum*), and *Sporobolus airoides*. These communities differ from our plots by having higher grass cover and by occurring in badland settings. Other *Atriplex gardneri*-dominated community types described in the state include *A. gardneri* / *Oryzopsis hymenoides* from southwestern Montana (Cooper et al. 1995), *A. gardneri* / *Moonless nuttallii* in the Prior Mountains vicinity of south-central Montana (DeVelice and Lusaka 1993), *A. gardneri* / *Pascopyrum smithii* from north-central Montana (Heidel and Cooper 1996) and *A. gardneri* / *Eriogonum pauciflorum* from northeastern Montana (DeVelice et al. 1995). *Eriogonum pauciflorum* is abundant in Carter County and forms communities also associated with shale ridge systems, although it more consistently occurs on lower slope and outwash flat positions; it is ostensibly associated with acidic substrates. In Carter County and contrary to the observations of DeVelice et al. (1995) for northeastern Montana, *E. pauciflorum* and *Atriplex gardneri* were never observed to codominate and seldom do their distributions even overlap. Branson et al. (1970) described both upland and lowland *Atriplex gardneri* communities in northeastern Montana. *Atriplex gardneri* communities in Montana appear to display distinct local variation, which defies lumping into a single plant association, but we are not prepared to recognize each species association as a discrete community without more information.

***Chrysothamnus nauseosus* / *Eriogonum pauciflorum* Community Type**

CHRNAU / ERIPAU; rubber rabbitbrush / few flowered buckwheat

MTNHP rank: to be determined

Environment: This previously poorly documented community type was sampled by 4 plots on BLM land in southern Carter County. It appears to be an early successional community on eroded alluvial and residual soils with shale parent material. It occurs in small, scabby, eroded patches on hillsides dominated by grasslands (PASSMI / STIVIR) and in larger patches where it represents an edaphic climax on alluvial outwash flats and low gradient drainages surrounded by sagebrush (ARTTSW/PASSMI) and greasewood (SARVER/ELYLAN) communities. Erosion, often severe, is evident at all sites, indicated by elevated rootstocks of the dominant subshrub, *Eriogonum pauciflorum*.

Vegetation: These sparsely vegetated communities are typically dominated by evenly spaced plants of the low, mat-forming subshrub *Eriogonum pauciflorum* with few other species present. (Note: *Eriogonum pauciflorum* is included under forbs in the constancy/cover tables (Appendix A)). Three plots sampled on alluvial outwash suggest a seral relationship between the named codominants. Two plots have sparse cover (about 20-30%) by *Eriogonum pauciflorum* and few other plants present, except the annual *Atriplex suckleya* which was well represented in one plot (putative earliest seral stage) and *Chrysothamnus nauseosus* was present in the other along with trace amounts of four grass species (*Koeleria macrantha*, *Poa compressa*, *P. juncifolia*, and *P. secunda*). In the third plot (putative most advanced seral stage) *Chrysothamnus nauseosus* was becoming well established (about 10% cover), and grew exclusively on elevated soil in clumps of dead *Eriogonum pauciflorum*, live plants of which persisted in trace amounts, and the rhizomatous wheatgrass *Elymus lanceolatus* was evenly scattered in the plot with about 10% cover. The fourth plot on scabby upland hillside is somewhat different, with higher shrub cover, *Eriogonum pauciflorum* (about 30% cover) sharing dominance with *Gutierrezia sarothrae* (about 20% cover). The bunchgrass *Oryzopsis hymenoides*, usually indicative of sandy sites, is common in this plot, and there is higher forb diversity (10 species), including the BLM Watch species and selenium indicator *Astragalus racemosus*.

Soils: The visual impression of these sites is expanses of bare soil (90 % plus) with scattered sub-shrubs, beneath the canopy of which and closely applied at the stem bases are trace amounts of litter. Judging by the tabulated results (see inset below) soils of all plots are at least slightly saline and three plots are derived from acid shales and one from non-acidic shale. Plot JV029 with non-acidic soils represents the atypical hillslope position with higher grass cover. Our soil values accord well with those of Branson et al. (1970) who correlated distribution of a similar *Eriogonum pauciflorum* community with acidic, shale-derived (Bearpaw Shale) soils having high gypsum (CaSO_4) content and relatively low clay content considering the parent material is platy shale. Mechanical weathering of some shales results in it fissuring into small plates, which in aggregate mimic a coarse-textured soil (resulting in relatively high infiltration rates and low fertility). Hydrolysis of gypsum causes the slightly acidic (pH 4.0-5.0) soil reaction. Note that the textural classes of our CHRNAU / ERIPAU soils are varieties of clays but that the percent clay composition is much less (49-58 %) than for the *Atriplex gardneri*-dominated sites (64-80 %). The high calcium concentration of a gypsiferous environment renders phosphate relatively unavailable as the calcium phosphate precipitate,

which further distinguishes the unique soil of this environment. The selenium indicators *Astragalus racemosus* and *Stanleya pinnata* were present in our upland plot.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0021	4.2	3.05	4	47	49	silty clay	1.43
97JV0022	4.6	0.85	6	36	58	Clay	1.55
97JV0029	7.7	2.17					
97JV0035	4.5	1.55					

Comments: An upland community dominated by *Eriogonum pauciflorum* (syn. *Eriogonum multiceps*) with *Chrysothamnus nauseosus* present was described from northeastern Montana (Branson et al. 1970), supporting the designation of ERIPAU/CHRNAU proposed here. No other descriptions of *Eriogonum pauciflorum* dominated communities have been found, although an *Eriogonum pauciflorum* xeric dwarf shrub series is listed for Montana in Cooper and DeVelice (1995) but no citation or distribution is given. An *Atriplex gardneri* (syn. *A. nuttallii*)/*Eriogonum pauciflorum* community type with *Chrysothamnus nauseosus* constant is described from northeastern Montana (DeVelice et al. 1995). In Carter County, *Atriplex nuttallii* and *Eriogonum pauciflorum* were never observed codominant, although topographic settings and overall aspect of communities dominated by each are similar (see discussion of ATRGAR/ ELYLAN). Branson et al. (1970) described communities in close juxtaposition dominated by each of these two species and found contrasting soil environments; soils of the *Atriplex gardneri*-dominated community are several time more alkaline, more saline, with higher clay and sodium content, and have half the infiltration rate.

***Sarcobatus vermiculatus* / *Elymus lanceolatus* Plant Association**

Syn. *Sarcobatus vermiculatus* / *Agropyron dasystachyum*

SARVER / ELYLAN; black greasewood / thick-spiked wheatgrass

MTNHP rank: G3/S3

Environment: Relatively large acreages of SARVER / ELYLAN are found on Carter County BLM tracts. It is a typical saline lowland range site on alluvial bottoms, but is also found on upland shale slopes. Upland examples occur in highly dissected drainage headwaters (e.g. North Cottonwood Creek) in patchy mosaics with ELYLAN grassland communities occupying drainage bottoms with alluvial soils and SARVER / ELYLAN occupying the residuum of the eroding shale substrate. *Sarcobatus vermiculatus* was also observed in badlands where it has an even more patchy distribution and reduced cover with obscured community structure and delimitation; other lifeforms have extremely sparse coverage on these badland sites. In bottomland settings (alluvial terraces and fans) SARVER/ELYLAN forms more extensive, uninterrupted communities, which are often bordered by and grade to sagebrush steppe (ARTTSW / ELYLAN) on better-drained soils, and riparian wetland stringers with *Populus deltoides* on wetter positions along creeks. In these bottomland settings black greasewood communities grade between jurisdictional wetlands and true upland environments (DeVelice et al. 1995, Hansen et al. 1995); regardless of where it occurs *S. vermiculatus* indicates the presence of unique soil properties indicating the plant associations present are edaphically conditioned.

Vegetation: SARVER/ELYLAN was sampled in five plots. *Sarcobatus vermiculatus* is the dominant shrub with cover ranging from about 10 to 38%. The shrubs *Artemisia tridentata* ssp. *wyomingensis* and *Gutierrezia sarothrae* have high constancy (75%) in the plots, the former sharing dominance with *Sarcobatus vermiculatus* in one plot (each with 10% cover), and the latter being well represented (10-20% cover) in two plots. The rhizomatous grass *Elymus lanceolatus* (syn. *Agropyron dasystachyum*) was identified as the lower layer dominant in all plots with cover ranging from about 20 to 70%. The morphologically and ecologically similar *Pascopyrum smithii* (syn. *Agropyron smithii*) was also identified in trace amounts in two plots. Other grasses with high constancy (>50%) include the natives *Koeleria macrantha* and *Poa juncifolia* and the exotic annual *Bromus japonicus*. The latter and the exotic perennial grass *Poa pratensis* are common increasers in this association and may be persistent; *Poa pratensis* is well represented in one plot even though the habitat was ungrazed for twelve years (C. Fruit, pers. commun.). Cover and diversity of forbs is relatively low; the natives *Achillea millefolium* and *Astragalus agrestis* and exotics *Taraxacum officinale* (or *T. laevigatum*) and *Tragopogon dubius* are the only species with greater than 50% constancy. The BLM watch species *Astragalus racemosus* was found in small numbers in two stands of SARVER / ELYLAN.

Soils: All the sites sampled had non-saline soils (conductivity of the saturation extract < 4 mmhos/cm). The soil of at least one site (97JV0048, see inset below) with a pH in excess of 8.5 is classed as a black alkali; soils of this type typically occur in semiarid regions in small irregular polygons known as slick spots. Though data regarding exchangeable sodium percentage was not run on any samples, the pH values less than 8.5 (single exception noted above) point to non-alkali soils. Hansen and Hoffman (1988) described a *S. vermiculatus* / *Pascopyrum smithii* type occurring on terraces and fans within Powder River Co. which closely matches our SARVER / ELYLAN (PASSMI) in vegetation composition and soil

parameters with pH ranging from 8.0 to 8.4 and texture being primarily loamy. *Sarcobatus*-dominated sites in our study may be contrasted with those sampled by Brown (1971) in Rosebud and Powder River Counties on badlands derived from the Fort Union Formation (sedimentary rocks ranging from sandstones to lignite coal beds but dominated by clay and silt shales). Brown's *Sarcobatus* Community had only 16% total vegetative canopy cover and on a percentage basis only 3 % of which was grass; thus the community represented in Brown's sampling was considerable more depauperate, especially in the graminoid component. The depauperate vegetation of Brown's sites probably reflect the fact that they were the most stressful of the badland sites he sampled in terms of soil chemistry (average conductivity 7.2, pH < 8.0 and sodium concentration of 9.1 me/ 100 g indicate saline-alkali soils), osmotic stress and lack of aeration. The *S. vermiculatus* / *Pseudoroegneria spicata* type of Hansen and Hoffman (1988), though possessing higher vegetative cover, is a close match for the sites described by Brown (1970) within these same two counties.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0003	7.5	0.16					
97JV0025	8.1	0.20	4	28	68	clay	3.92
97JV0033	7.9	1.04					
97JV0036	7.5	2.06					
97JV0048	8.6	0.37	2	46	52	silty clay	1.88

Comments: SARVER/ELYLAN was described from the Yellow Triangle area of eastern Montana by Jorgensen (1979), but has not been reported elsewhere. The ecologically similar (equivalent?) SARVER/PASSMI, with *Pascopyrum smithii* replacing *Elymus lanceolatus* as the dominant grass, has been described by numerous studies. Bottomland SARVER/PASSMI communities are documented from north-central (Mackie 1970) and northeastern (DeVelice et al. 1995), southeastern (Hansen and Hoffman 1988, Ecological Consulting Service 1975, Olsen-Elliott and Associates 1980) and southwestern Montana (Mueggler and Stewart 1980, Cooper et al. 1995) as well as western North Dakota (Jensen et al. 1992), Wyoming, South Dakota, Nebraska, and Saskatchewan (The Nature Conservancy 1997). One of these studies (Ecological Consulting Service 1975) identified SARVER/PASSMI in Carter County in the Thompson Creek drainage not far from one of our plots of SARVER/ELYLAN. Due to the difficulty of distinguishing between *Elymus lanceolatus* and *Pascopyrum smithii* and their apparent overlapping ecological distributions it may be best to consider communities with either grass dominant in the same plant association, but we have designated the type SARVER/ELYLAN to emphasize local trends in floristic composition. Upland greasewood communities are less commonly reported in the literature. A badland *Sarcobatus vermiculatus* community was described from Rosebud and Powder River Counties, Montana with slopes ranging from 0 to 80%, however, neither *Elymus lanceolatus* nor *Pascopyrum smithii* or any other herb approach dominance (Brown 1971); ecologically this community is closer to the *S. vermiculatus* / *Pseudoroegneria spicata* topoedaphic climax habitat type described by Hanson and Hoffman (1988) as occurring on shale-derived small-scale terraces.

Bottomlands occupied by greasewood communities are often used intensely by livestock, and may be cultivated. Although *Sarcobatus vermiculatus* is toxic to both cattle and sheep, it may be browsed and, depending on season and intensity of use, may be an increaser or decreaser under grazing (Hansen et al. 1995). The grass component of these communities is highly palatable and decreases under heavy grazing. One of our sampled stands of SARVER/ELYLAN which was ungrazed for 12 or more years had relatively high cover by both shrub (about 38% cover) and grass (about 70%).

GRAMINOID- and FORB-DOMINATED VEGETATION TYPES

Artemisia longifolia / *Oryzopsis hymenoides* Community Type

ARTLON/ORYHYM; long leaved sagewort / indian ricegrass

MTNHP rank: G2/S2

Environment: This plant community is a localized feature of breaklands and badlands on slopes and benches. It was sampled at one site on barren, dissected, acid shale uplands above Keith Creek, a headwaters tributary of the Powder River in the west-central segment of the county. In the study area it occurs in very small bands and patches restricted to steep, eroding ridge shoulders. We interpret it to occur on Pierre Shale formations directly overlying the erodable Hell Creek Formation, based on general bedrock geology maps (Ross et al. 1955). The sampled plot has a north aspect but the community was observed nearby on a variety of aspects. Outside Carter County it has been documented only from north-central Montana badlands (DeVelice 1995, Faber-Langendoen et al. 1997, and citations therein).

Vegetation: The plot corresponds floristically in other respects to the community type described from north central Montana (DeVelice et al. 1995), though lacking the indicator indian ricegrass (*Oryzopsis hymenoides*). The herbaceous to sub-shrub sagewort, *Artemisia longifolia*, dominates with about 30% cover, while *Eriogonum pauciflorum* is codominant with about 10% cover. Also present in trace amounts are the short stature *Rosa arkansana*, the only true-shrub present, and the forb *Thermopsis rhombifolia*, which are considered diagnostic of the type (Faber-Langendoen 1997). In our plot, the forb *Iva axillaris* is common with about 3% cover. Grasses occur only in trace amounts.

Adjacent, less erodable slopes are occupied by *Juniperus scopulorum* (JUNCON/ORYMIC) and *Pinus ponderosa* (PINPON/JUNSCO) communities. The ridgetops are nearly devoid of vegetation or support annuals such as *Atriplex suckleya* or *Suaeda calceoliformis*, or are infested with *Melilotus officinalis*. Draw and gully bottoms are dominated by rhizomatous wheatgrass (*Elymus lanceolatus* and/or *Pascopyrum smithii*) community types.

Soils: All known occurrences of this community type are on acid marine shales or bentonite. Our one sampled site is no exception, as can be seen from the inset below; pH is moderately acidic, the texture is clay, and the electrical conductivity indicates substantial amounts of salt, though not enough to qualify soils as being saline. These substrates are quite similar to those of the CHRNAU / ERIPAU community type but, more highly eroded, suggesting perhaps that ARTLON / ORYHYM may represent an early seral stage of CHRNAU / ERIPAU, or at least an analogous environment.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0040	4.8	1.91	4	23	73	clay	0.51

Comments: This community type is provisionally identified as a rare type known only from Montana (Faber-Langendoen et al. 1997). It is not a significant rangeland resource. We maintain that it may be

underdocumented in the literature and that it warrants either subdivision into different associations or a more robust description. Long-leaved sagewort has been observed with wheatgrasses as the predominant graminoid from BLM-administered lands in Fergus and Toole counties in north central Montana, as well as from the North Unit of Theodore Roosevelt National Park where it is a successional community. Few species can survive and flourish in this extreme environment. While indian ricegrass may be a good indicator in parts of north-central Montana, it is also part of a suite of various stress-adapted species that seems to have low fidelity with one another. We recommend recognition of the *Artemisia longifolia*-dominated communities at the alliance or series level for the present, perhaps in combination with the *Chrysothamnus nauseosus* alliance/series. They may sort out consistently by plant association if one were to consider the geological formation and landform with each plant community. Pending this multi-state review, a revised status undetermined rank is recommended.

In the study area, this type may be threatened by encroachment of introduced *Melilotus officinalis*, which is becoming dominant on much of the otherwise barren slopes in the vicinity. Another rare community (Faber-Langendoen et al. 1997), *Juniperus scopulorum*/*Oryzopsis micrantha*, also occurs at this locality. While such shale uplands have a fragile surface, there were no current land uses identified that pose a threat to them.

***Calamovilfa longifolia* / *Carex inops* ssp. *heliophila* Plant Association**
(syn. *Calamovilfa longifolia* / *Carex heliophila* var. *inops* or *Carex pennsylvanica*)
CALLON / CARINO; prairie sandreed / sun sedge
MTNHP rank: G3/S3

Environment: This plant association type usually occurs in small patches (fractions of an acre) with abrupt ecotones to associated grassland, shrub and forest types, but is widespread in Carter County on substrates derived primarily from sandstone. It constitutes an edaphic climax in sandy range sites, i.e., with effectively coarse substrates and high infiltration rates. It may also occur on shale, if the product of mechanical decomposition is dominated by sand-sized (and larger) platy particles, a condition observed elsewhere in Carter County and as far west as Phillips County. In southern Carter County this type was sampled at two sites in alluvial washes draining eroded ridges.

Vegetation: Respective cover by the two rhizomatous indicator species, *Calamovilfa longifolia*, a grass, and *Carex inops*, a sedge, varies greatly between the two plots. At the site on sandstone, there is high cover by both grass (ca. 70%) and sedge (ca. 40%), and there is near total ground cover by litter. Except for the weedy exotic annual grass, *Bromus japonicus* (ca. 20% cover, in patches), other graminoids and especially forbs and shrubs are few and found only in trace amounts. Species richness (23) is the lowest of any type sampled with the exception of the saline- and alkali-stressed types such as SARVER / ELYLAN. DeVelice et al. (1995) also found low forb cover and richness (av. 10 species / site) for this association in northeastern Montana. The plot on shale substrate has much lower total cover, and here *Carex inops* is dominant with about 40% cover; *Calamovilfa longifolia* has only about 10% cover and *Rosa arkansana* is also well represented with about 10% cover. Bimodal pattern of floristic composition of our plots on shale vs. sandstone is consistent with stands of CALON / CARINO on these respective substrates in northeastern Montana (DeVelice et al. 1995). We note that these species are not consistently found together on the respective substrates, and further vegetation sampling may warrant a split in this unit as representing two discrete types.

This type was surrounded by sagebrush (ARTTSW / ELYLAN) and grassland (ELYLAN) types occupying less eroded positions; it was also observed in alluvial wash openings of oak woodlands (QUEMAC / CARINO) on the toe-slopes of a bentonite ridge. In northern Carter County it was sampled on BLM land near Mill Iron on resistant upland sandstone mesas, where it occurs in small patches with abrupt edges, usually in water collecting positions, within matrix grasslands of STICOM - CARFIL. It has not been determined what factors distinguish sites of this association from contiguous types or types occurring on very similar landscape positions and coarse-textured soils, e.g. STICOM - CARINO or STICOM - CARFIL; CALLON ñ CARINO may have a more favorable water balance, associated with collecting positions. It differs from SCHSCO ñ CARINO in not being associated with upper slope to slope shoulder positions subject to erosion (though it may be in a sediment-receiving position).

Soils: The coarse textured substrates (sandy loams) and leached nature of these sites is reflected in relatively low values for pH and conductivity. Hanson and Hoffman (1988) found very similar values for these soil variables in the same association across the Ashland District of the Custer National Forest. The co-dominance of *Calamovilfa longifolia* and *Rosa arkansana* (with *Eriogonum pauciflorum*) in a

imixed shrub community on shale in northeastern Montana was attributed to coarse textured substrate (loose platy material with high infiltration rates) weathered from shale with low montmorillonite content (Branson et al. 1970). As with the Carter Co. representation of the CALLON ñ CARINO type, the northeastern imixed shrub community), had the lowest values of any community within its local matrix for a number of variables (total soluble cations, pH, conductivity.) *Calamovilfa longifolia* is a deep-rooted, cool season grass that exploits deep soil moisture, and becomes dominant on substrates with high infiltration rates and little runoff (Culwell et al. 1986, Hanson and Hoffman 1988).

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0012	6.9	0.06	73	18	9	sandy loam	1.90
97JV0018	5.5	0.06					

Comments: Near pristine vegetation sampled by Ross et al. (1973) on sandy loam soils in the Chalk Buttes unit of the Custer National Forest in Carter County matches this type, except that the indicated codominant sedge was *Carex filifolia*. A similar association with *Carex filifolia* was observed elsewhere in the Carter County, though not documented. The habitat requirements and plant association fidelities of *Carex filifolia* vs. *C. inops* ssp. *heliophila* require further investigation.

Coupland (1961) hypothesizes that this type (or any site dominated by a suite of tall isand grasses, e.g. *Calamagrostis montanensis*, *Oryzopsis hymenoides*, *Elymus canadensis*) to be autogenically driven to the *Stipa (comata) ñ Bouteloua (gracilis) ñ Agropyron (dasystachyum)* faciation (a broadly defined community type). However, we agree with Hansen and Hoffman (1988) that this is an edaphic climax type, and that these sites possess a unique suite of soil descriptors.

***Eleocharis palustris* (*E. xyridiformis*) Community Type**

ELEPAL (ELEXYR); spikerush

MTNHP rank: G5/S5

Environment: This wetland community type was sampled once on BLM land in the Cottonwood Creek drainage in west-central Carter County, where it occurs in a seasonally flooded drainage that floods at other times of the year after major precipitation events. It is an overflow range site and occupies the wettest microsites in low spots and along the drainage channel. It is interpreted to represent a natural type, though the watercourse setting has been altered by ditches, impoundments and a road crossing, and is grazed by cattle in the fall. Elsewhere ELYPAL was observed in small patches in roadside ditches, in the bottoms of intermittent drainages, and around stockponds.

Vegetation: This shallow marsh community type is dominated by a spikerush, provisionally identified as *Eleocharis xyridiformis*. The species is included in Flora of the Great Plains (Great Plains Flora Association 1986) which indicates a Montana distribution based in part on a collection from Carter County. But the taxon is not recognized in other local floras (Booth 1950, Dorn 1984, 1992, Hitchcock and Cronquist 1973) and is subsumed in *Eleocharis palustris* by Kartesz (1994). It is part of the Palustres group and distinguished from *E. palustris* in having flattened, twisted culms. Plants that key to *Eleocharis xyridiformis* were found to be common by 1997 surveys in western and southern Carter County. In the floras that do not recognize *Eleocharis xyridiformis*, these plants key to *Eleocharis palustris*. Specimens were collected and a specialist is sought to resolve the taxonomy of these plants. Two forms (putative species) of spikerushes of the Palustres group (*E. palustris* in a broad sense) were observed growing together around stockponds in Carter County. Larger plants with terete culms (typical Montana *E. palustris*, or in Flora of the Great Plains keying to *E. macrostachya*) occupied a slightly wetter zone than plants with twisted, flattened culms (putative *E. xyridiformis*). The latter is more abundant and is the sole dominant spikerush in the community described here. It is possible that the two morphologies are a result of plant water status.

Vegetation of the sampled plot is dominated by dense patches of the medium height *Eleocharis palustris* with about 70% total cover. Grasses include *Elymus lanceolatus* (about 10% cover), *Hordeum jubatum* (about 3% cover) and *Beckmannia syzigachne* (about 2% cover). The miniature spikerush *Eleocharis acicularis* is present, and a small patch of cattails, *Typha latifolia*, has become established. Forb diversity is low, but *Polygonum ramosissimum* and *Rumex crispus* are common.

Wetland margins are dominated by *Elymus lanceolatus* communities (ELYLAN), a temporarily inundated meadow community with high cover by *Hordeum jubatum*.

Soils: Soils are fine textured, seasonally flooded, and extremely poorly drained.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0049	8.5	0.42	-	-	-	-	1.21

Comments: Carter County stands resemble descriptions of *Eleocharis palustris* communities from Montana (Cooper et al. 1995, Hansen et al. 1995). Taxonomic clarification will either confirm that these are taxonomic equivalents, or that they are genetically distinct but that as community dominants they may warrant treatment as ecological equivalents.

Wetlands and wetland habitat along watercourses are scarce in Carter County, found mostly as meadow and shallow marsh wetland associations. Stockponds have been developed in most drainages. The wetland where vegetation was sampled has been partially altered by changes to hydrology. There may also be alteration caused by cattle trampling and invasion by species such as *Hordeum jubatum*, *Rumex crispus*, and *Typha latifolia*, though spikerushes are unpalatable (Hansen et al. 1995) and their rhizomatous habit makes them resistant to grazing.

***Pascopyrum smithii* (*Elymus lanceolatus*) Plant Association**
syn. *Agropyron smithii* (*Agropyron dasystachyum*)
ELYLAN (PASSMI); thick-spiked wheatgrass (western wheatgrass)
MTNHP rank: G3G5/S4

Environment: This is a major plant association throughout Carter County and is the predominant grassland association of BLM lands in the southern part. It occurs on fine textured soils derived from shale parent materials, most commonly on lower slopes of rolling hills and along intermittent drainages. As here described, the association generally occurs in mesic (water collecting) topographic positions, and a small fraction may qualify as jurisdictional wetlands. It is perhaps most consistently found as a clayey range site, but is also found on shallow clay, overflow, silty, and other range sites. Floodplain examples of the type are seasonally flooded in most years and may be flooded intermittently after summer storms.

Vegetation: This association is characterized by high cover (70-90% in the plots) of the rhizomatous wheatgrasses, *Elymus lanceolatus* and/or *Pascopyrum smithii*. *Elymus lanceolatus* was the species identified in our 4 plots and is probably the more common in southern Carter County, but the two species may grow intermixed and are difficult to distinguish, especially in vegetative condition. We have chose to include communities with either grass dominant in the same plant association, due to the difficulty of distinguishing the two species, the possibility of hybridization (Great Plains Flora Association 1986), and their apparently overlapping ecological distributions. We refer to the type by the more widely-recognized name, PASSMI, pending taxonomic and community classification review.

Under good range condition, other grasses are poorly represented, but *Stipa viridula* was present in trace amounts in all plots (see description of ELYLAN - STIVIR for stands with *Stipa viridula* well represented). Most stands have been invaded by the exotic annual grasses *Bromus japonicus* or *B. tectorum*. These species are abundant in poor condition upland examples of this type, and the exotic rhizomatous grass *Poa pratensis* is abundant in floodplain stands. Waif shrubs (*Artemisia tridentata* ssp. *wyomingensis*, *Sarcobatus vermiculatus*) from surrounding communities occur in many stands, and the low shrub *Rosa arkansana* had 30% cover in one plot within a tall enclosure (but much lower cover outside). Forb diversity is relatively low (18 species in 4 plots), but the alien *Melilotus officinalis* had about 20% cover in the plot within an enclosure (less cover outside), and *Helianthus maximiliani* had about 30% cover in a floodplain plot. Forbs with high constancy (75%) were *Achillea millefolium*, *Aster falcatus*, *Thermopsis rhombifolia*, *Tragopogon dubius*, and *Vicia americana*.

Bottomland stands often grade to greasewood communities (SARVER/ELYLAN) and upland stands often grade to sagebrush steppe (ARTTSW/ELYLAN) but the controlling factors among these types are not always clear.

Soils: Soils are iheavy, primarily clays and silty clays rated as nonsaline and just verging into the alkaline range (defined as pH 8.5-10), judging by their high pH values (see inset below), though we have no exchangeable sodium data for confirmation.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0026	8.0	0.56	8	30	62	clay	3.74
97JV0032	8.4	1.00	-	-	-	-	-
97JV0034	8.3	0.15	3	45	52	silty clay	2.69
97JV0044	8.2	0.67	-	-	-	-	-

Comments: Due to high productivity of palatable grass and central position in the landscape, stands of ELYLAN (PASSMI) usually receive heavy use by livestock. Some remote BLM lands (e.g. Cottonwood Creek Drainage), however, have stands that have been lightly grazed or ungrazed for up to twelve years (C. Fruit, pers. commun.). Four good to excellent condition stands of ELYLAN (PASSMI) were sampled on BLM lands, all in southern Carter County, two are in floodplains and two are on lower slopes, one of the latter is within an enclosure.

The dominant species have broad ecological amplitudes and discrete modalities that sort by multiple environmental and disturbance factors, so it is particularly challenging to differentiate this type from other types and circumscribe the variation within it. As here described, PASSMI (ELYLAN) most closely resembles descriptions in the literature of grassland types dominated by *Pascopyrum smithii*. Although landscape position is similar, our plots lack the indicated codominants of *Pascopyrum smithii* / *Bouteloua gracilis* communities in northeastern Montana (DeVelice et al. 1995) and *Pascopyrum smithii* / *Carex filifolia* communities cited for North and South Dakota (Hansen et al. 1984, Hansen and Hoffman 1988). In multi-state classifications (Schneider et al. 1997) the two previously mentioned plant associations were combined into the *Pascopyrum smithii* ñ *Bouteloua gracilis* ñ *Carex filifolia* plant association when analyses showed no difference in site descriptors between the two community types, they differed only in relative proportions of the sub-dominant graminoids. A community dominated by *Pascopyrum smithii* and *Bouteloua gracilis* (also with abundant *Bromus japonicus*) was described from the Thompson Creek drainage in southern Carter County (Ecological Consulting Service 1975) and this community type was observed in northern Carter County on reconnaissance surveys. *Bouteloua gracilis* is favored by overgrazing (Hansen and Hoffman 1988) and it is difficult to attribute its dominance in some Carter County grasslands (usually with *Bromus japonicus* also abundant) to either edaphic factors (more coarse textured soil) or grazing pressure.

Hansen et al. (1995) describe late seral to climax wetland communities in Montana dominated by nearly pure stands of *Pascopyrum smithii*; *Bouteloua gracilis* was found only in disturbed, and/or early to mid seral stands of this sample set. In contrast, one northeastern Montana study (Branson et al. 1970) illustrates the influence of soil type on distribution of *Bouteloua gracilis*; the species was absent from floodplains dominated by *Pascopyrum smithii* but the two grasses were codominant nearby on dryer, warmer soils. An abundance of *Nasella (Stipa) viridula* is documented for some wetland and drainage bottom *Pascopyrum smithii* types (Culwell and Scow 1982, Hansen et al. 1995), but it is interesting to note that *N. viridula* is more abundant in upland grasslands in southern Carter County (see discussion of ELYLAN (PASSMI) / STIVIR). This may reflect their occupying collecting positions in the landscape and having medium to coarse-textured soils (which may have greater amounts of water above the wilting point available to *N. viridula*).

***Pascopyrum smithii* (*Elymus lanceolatus*) - *Nasella viridula* Plant Association**

(syn. *Agropyron smithii* (*A. dasystachyum*) - *Stipa viridula*)

ELYLAN(PASSMI) / NASVIR; thick-spiked wheatgrass (western wheatgrass)/green needlegrass

MTNHP rank: G4/S3

Environment: ELYLAN (PASSMI)/ NASVIR is a distinctive but localized grassland type which was sampled twice in the South Cottonwood/Duncan Creek drainage, where it occupies both northerly and southerly aspect side slopes of low relief shale ridges in clayey range sites. This is not a typical mesic side slope setting for it, so the surrounding features and their associations are described for context. There are occasional eroded blowouts in the same area with little grass cover and dominated by *Eriogonum pauciflorum* (ERIPAU). Downslope positions with alluvial soils have higher grass cover (included in our description of ELYLAN). The eroded shale ridgetops (some with bentonite cores) are dominated by *Atriplex gardneri* (ATRGAR/ELYLAN). There is little evidence of recent grazing in these grasslands; the stand at Duncan Creek is within an allotment, which has been ungrazed for 12 years or more (C. Fruit, pers. commun.).

Vegetation: The plots have moderate cover dominated by the grasses *Elymus lanceolatus* (syn. *Agropyron dasystachyum*), with about 30% cover, and *Nasella* (syn. *Stipa*) *viridula*, with about 10% cover. Other grasses are limited to *Oryzopsis hymenoides* common in one plot and *Muhlenbergia cuspidata* present in trace amount in the other. The shrub *Gutierrezia sarothrae* is present in both plots. There is high diversity and distinctive assemblage of forbs (14 and 20 species in the plots) with the following species constant: *Aster falcatus*, *Cryptantha celosoides*, *Dalea candida*, *Eriogonum pauciflorum*, *Hymenoxys acaulis*, *Phlox hoodii*, *Senecio canus*, and *Tragopogon dubius*. The selenium indicators *Astragalus racemosus* (a BLM Watch species) and *Stanleya pinnata* were found in one plot and were observed in nearby similar habitat outside of the other plot.

Soils: Presence of selenium at these sites is indicated by species which require high selenium in soil, and their associated smell.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0030	7.6	0.66	-	-	-	-	-
97JV0046	7.8	2.03	17	38	45	Clay	2.5

Comments: Relict grasslands dominated by *Elymus lanceolatus* or *Pascopyrum smithii* with an important component of *Nasella* (*Stipa*) *viridula* were described from southwestern North Dakota (Whitman 1979) and Saskatchewan (Coupland 1961). The latter report, and a relict area report (Quinnild and Cosby 1959) note the difficulty of distinguishing between *Elymus lanceolatus* and *Pascopyrum smithii*, especially in vegetative condition, but none the less, document their occurrence and relative abundance in communities and suggest causal mechanisms. Coupland states that *Elymus lanceolatus* is more abundant on cooler, finer-textured soils, while *Pascopyrum smithii* is more abundant on warmer, sandier soils and on disturbed soils, and that this adaptation is reflected in the geographical distribution of their community types, with *Elymus lanceolatus* types becoming less common to the south. Quinnild and Cosby documented communities dominated by each species on ungrazed butte tops, and suggested that dominance of *Elymus lanceolatus* on one butte top reflected a longer fire interval and absence of a single hay-cutting that the *Pascopyrum smithii* dominated butte top had received.

We did not identify *Pascopyrum smithii* in our plots, but its absence is not certain. *Elymus lanceolatus* and *Pascopyrum smithii* have similar ecological adaptations and may grow intermixed (Coupland 1960, Ecological Consulting Service 1975, Jorgensen 1979, Quinnild and Cosby 1958). DeVelice et al. (1995) treat the two wheatgrasses as ecological equivalents in their discussion of a *Pascopyrum smithii* / *Stipa viridula* plant association in northeastern Montana.

Abundance of *Stipa viridula* is thought to be indicative of fine- to medium-textured soils, mesic soil moisture regimes, and low levels of grazing (Branson et al. 1970, Jorgenson 1979, Coupland 1960, DeVelice et al. 1995). However, in southern Carter County, *Stipa viridula* was less abundant in drainage bottom grasslands dominated by nearly pure stands of *Elymus lanceolatus* (see discussion of ELYLAN) than it was in uplands. Our plots of ELYLAN / STIVIR probably represent outliers of the type, appearing to differ from like-named communities described in the literature in the following respects: 1) relatively low cover by grasses despite low levels of grazing 2) absence of the graminoids *Koeleria macrantha*, *Bouteloua gracilis*, and *Carex filifolia*, 3) presence of *Eriogonum pauciflorum* (perhaps indicative of some admixture of acid shale circumstantially suggested by the low pH values relative to PASSMI [ELYLAN] and 4) distinct composition and high diversity of forbs, including obligate selenophytes. The best modal description of this association is found in Jensen et al. (1992).

***Schizachyrium scoparium* - *Carex filifolia* Plant Association**

(syn. *Andropogon scoparius* - *Carex filifolia*)

SCHSCO / CARFIL; little bluestem / thread-leafed sedge

MTNHP rank: G4/S3

Environment: SCHSCO/CARFIL was sampled twice on BLM land in the northern part of the county east of Mill Iron and in southwest corner south of Hammond. Both sites have sandstone derived soils and the communities are small patches in mosaics with ponderosa pine (PINPON / JUNHOR, PINPON / PSESPI, and PINPON / SCHSCO) and grassland (STICOM / CARFIL, CALLON / CARINO) communities. Stands of little bluestem observed in Carter County were usually small in size and limited to specialized topographic positions or disturbance regimes, primarily on substrates derived from sandstone. It was seen both on ridge shoulders above slumping escarpments, and on the toeslope deposits below, part of thin hilly range sites. Hansen and Whitman (1938) described how *S. scoparium* is capable of colonizing areas of step-erosion on northerly slopes and is an effective competitor that, once established, shows no sign of being replaced on these sites. Similar observations have been made on coarse-textured substrates throughout extreme eastern Montana in the course of other studies, which establishes SCHSCO ñ CARFIL as a topoedaphic climax type. This type is usually associated with outcrops and escarpments, which support ponderosa pine; some stands appear to be seral to ponderosa pine communities (see discussion of PINPON/SCHSCO). Just west of Alzada (on what appeared to be a shale-derived soil) a fallow field was observed with little bluestem, an apparent primary successor on abandoned fields.

Vegetation: Large bunches of the warm season grass *Schizachyrium scoparium* are the distinctive visual indicator of this community type, taller than the codominant low, clump forming sedge *Carex filifolia*. Either species may be dominant; cover of *Schizachyrium scoparium* was around 30% and 40% and cover of *Carex filifolia* was around 10% and 50% in the two respective plots. The plots have a high diversity of grasses and forbs. In addition to the dominants, grasses in both plots include *Calamovilfa longifolia*, *Koeleria macrantha*, *Stipa comata*, and *Vulpia octoflora*. There is a total of 28 species of forbs in the 2 plots but only *Lygodesmia juncea*, *Polygala alba*, and *Psoralea argophylla* are in both. *Pinus ponderosa* and the shrubs *Artemisia frigida* and *Yucca glauca* are present in trace amounts in both plots.

Soils: In the study area, we found SCHSCO - CARFIL exclusively on coarse textured soils derived from sandstone parent materials, consistent with Hansen and Hoffman (1988). A grassland community dominated by little bluestem is also documented on shale derived substrate in the Thompson Creek drainage west of Alzada (Ecological Consulting Service 1975). DeVelice et al. (1995) noted that these non-sandstone occurrences can be explained by the fact that fissile shale can mimic sandstone in effective soil texture and water-holding capacity. In western North Dakota, Jensen et al. (1992) have found this type in the same topographic positions (primarily steep, upper slopes of all aspects) but with parent materials varying from sandstone to mixed sedimentary rock and glacial till. White (1970) states that *S. scoparius* will grow on substrates (shale) that should ostensibly weather to fine-textured soils, if rock (shale) fragments are present.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0001	8.5	0.10	46	33	21	loam	-
97JV0013	7.4	0.05	55	30	15	sandy loam	-

Comments: SCHSCO/CARFIL has been documented from northeastern Montana (DeVelice et al. 1995), and from southeastern Montana, western and southwestern North Dakota, and northwestern South Dakota (Hansen et al. 1984, Jensen et al. 1992, Hansen & Hoffman 1988). It appears to favor steep upper slopes of moderate to high erosion potential but, it occurs on a variety of topographic positions and aspects. Plots across its range demonstrate a remarkable compositional similarity. Within the study area, as in northeastern Montana, stands are usually small, but more extensive stands are found in North Dakota. Hansen et al. (1984) consider SCHSCO/CARFIL a topoedaphic climax but *Schizachyrium scoparium* may also be a seral dominant following erosion events and possibly fire. The community composition of clearly seral stands was not documented by this study (except see PINPON/SCHSCO), and seral stage of the documented stands is uncertain. Jensen et al. (1992) provide the best documentation of this plant association recognizing Ecological Types that are either grazing-induced seral community types or that represent edaphic condition that differ from the modal potential natural vegetation.

***Spartina pectinata* Plant Association**

SPAPEC; prairie cordgrass

MTNHP rank: G3/S3

Environment: This is perhaps the most abundant of naturally occurring wetland types on BLM land in Carter County. It occurs in floodplains of ephemeral and permanently flooded streams in subirrigated settings. In rangelands on shale substrates where there is otherwise little or no permanent standing water, intermittent drainages are usually dammed to create stockponds; narrow and patchy wetland habitat above and below stockponds is often dominated by the rhizomatous grass *Spartina pectinata*. Two relatively undisturbed examples of SPAPEC were sampled, one in an intermittent wash off a shale ridge system, headwaters of Short Creek, and another in the more or less permanently flooded canyon bottom of East Fork Little Powder River. The Short Creek site occurs in a landscape of low-relief uplands dominated by sagebrush steppe (ARTTSW / ELYLAN) while the Little Powder River site is in a box canyon which cuts eroded breaklands and benchlands dominated by silver sage (ARTCAN/PASSMI) and grasslands (STICOM/CARFIL) with scattered ponderosa pine. Adjacent wetland types at the Little Powder River site were dominated by *Equisetum laevigatum* and *Scirpus pungens*.

Vegetation: The two sampled plots represent a broad range in hydrological conditions to which *Spartina pectinata* is adapted and functions as a dominant. The plot in an ephemeral wash has about 50% cover by *Spartina pectinata* with near complete cover (of both live foliage and litter) in patches which form terraces in a mosaic with bare soil of recent alluvial deposition. There is little cover by other species, the grasses *Agrostis scabra* and *Poa juncifolia* and forbs *Aster falcatus*, *Polygonum ramosissimum*, and *Thermopsis rhombifolia* form a distinctive assemblage, but occur in only trace amounts. The plot in the permanently saturated, low gradient floodplain contrasts by being less patchy and by having a taller, more dense sward of *Spartina pectinata* (about 90% cover), significant cover (about 10%) by *Scirpus pungens* and a different assemblage of characteristic tall, wet-site forbs (*Asclepias speciosa*, *Rumex crispus*, and *Solidago canadensis*).

Soils: The floodplain site exhibited soils with strong gleying and no evidence of mottling. The other site, located in an intermittent wash, possessed neither wetland soil feature but, owing to its topographic position below and adjacent to an acid shale ridge system, its soil reaction was moderately acid (see inset below), with a hydrogen ion concentration more than 100 times greater than any SPAPEC site sampled to date (Hansen et al. 1995). Conductivities indicate only mildly saline conditions. Appraising soil texture by feel indicates both soils were silt loams.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0024	4.6	0.66	-	-	-	-	-
97JV0039	8.2	0.63	-	-	-	-	-

Comments: An upland marsh habitat type dominated by *Spartina gracilis* (71% cover) and *Muhlenbergia asperifolia* (10% cover) was described in southern Carter County in the bentonite mining district (Ecological Consulting Service 1975). Hansen et al. (1995) include wetlands dominated by *Spartina*

gracilis in the SPAPEC habitat type, even though this species is characterized as reaching its highest cover values under subsaline conditions (Stewart 1972), a higher range than *S. pectinata*. Culwell and Scow (1982) sampled *Spartina pectinata* communities from eastern Montana in Custer County with similarities to both of our plots. Our combined data support recognition of a distinct phase (SPAPEC - SCIPUN) distinguished by having *Scirpus pungens* well represented and *Equisetum laevigatum* present.

***Stipa comata* - *Carex filifolia* Plant Association**
STICOM - CARFIL; needle-and-thread (-) threadleaf sedge
MTNHP rank: G5/S4

Environment: This is the predominant grassland type in Carter County on uplands with soils derived from sandstone parent materials; it occurs on planar surfaces, gently rolling plateaus, tops of buttes, and gentle slopes of all aspects, though it is more prevalent on warmer exposures. It is most consistently found in shallow to gravel range sites, but is in a variety of others. STICOM/CARFIL is also consistently found in well-developed sandplains representing sands or sandy range sites, though such settings are nearly absent from BLM land in Carter County.

Vegetation: In the five plots of STICOM/CARFIL sampled, 62 species were tallied (Appendix A). Although *Stipa comata* is the more conspicuous of the codominant graminoids (both with an average cover of 36%), *Carex filifolia* had greater cover in three of the plots. Cover by *Stipa comata* ranged from 20 to 70% and cover by *Carex filifolia* ranged from 10 to 60 %. These canopy cover values are decidedly less (by an average of 40 and 18 %) than reported by Hansen and Hoffman (1988) for the same association, in the same vicinity. This discrepancy in productivity could be explained by year of sampling, past grazing history and the higher elevations (inferred greater precipitation) of the Hansen & Hoffman plots.

No other grasses were 100 % constant but, a rhizomatous wheatgrass, either *Pascopyrum smithii* or *Elymus lanceolatus*, and *Bouteloua gracilis* were sometimes well represented (up to 10% cover) and occurred in 80 % of the plots. The subshrub *Artemisia frigida* was the only woody species with over 50% constancy. The diversity of forbs varied greatly between plots and is believed to be a reflection of grazing regime. One plot, apparently ungrazed in recent years, had 18 forb species, while a plot with evidence of heavy use by sheep in recent years had only 8 species. Forbs with high constancy ($\geq 60\%$) included *Cirsium undulatum*, *Lygodesmia juncea*, *Opuntia polyacantha*, *Phlox hoodii*, *Plantago patagonica*, *Psoralea argophylla*, *Sphaeralcea coccinea*, and *Tragopogon dubius*. The fact that all the previously mentioned species are increaser or weedy may infer a generally poor condition of the sampled stands of this association or alternatively they may simply constitute the native composition of this type. Judging by the data of Hansen and Hoffman, who patiently sought out relict or relatively undisturbed stands, this composition does not reflect a degraded condition; one can speculate that if these plots represent degraded examples then the canopy cover of annual brome grasses would be greater. The clubmoss, *Selaginella densa* is 80 % constant and well represented in two plots currently grazed by sheep.

Adjacent communities commonly include *Pinus ponderosa* communities on slopes and ridges, and *Artemisia cana* communities (ARTCAN/PASSMI) on downslope alluvial terraces and in swales of upland slopes. However, most frequently STICOM ñ CARFIL grades to *Pascopyrum smithii*-, or *Artemisia tridentata* ssp. *wyomingensis*-dominated matrix type plant communities, such as ARTTSW / ELYLAN or ELYLAN ñBOUGRA- CARFIL. Patches of *Calamovilfa longifolia* / *Carex inops* are often included within the larger matrices of STICOM/CARFIL, usually in water collecting positions. Along sandstone/shale contact zones there is often an abrupt transition from STICOM/CARFIL on sandy soils (often the higher positions in the landscape) to grasslands or shrublands on shale derived soils with the grasses *Elymus lanceolatus* or *Pascopyrum smithii* dominant.

Soils: Plots were on residuum derived from what was judged to be sandstone, but the clay component was still appreciable (18-29 %) and the textures ranged from loams to clay loams. With the exception of other community types developed exclusively on sandstone substrates (*Pinus ponderosa* series and CALLON ñ CARINO plant association) soils of this association have the lowest electrical conductivities, reflecting both the nature of the substrate and the greater effective leaching associated with coarse substrates.

Sample No.	pH	EC, mmhos/cm	Sand %	Silt %	Clay %	Texture	Organic Matter %
97JV0002	7.9	0.10	43	36	21	Loam	4.13
97JV0015	6.8	0.04	42	30	18	Loam	-
97JV0037	8.1	0.11	-	-	-	-	-
97JV0050	7.7	0.08	38	33	29	clay loam	2.56

Comments: The few areas of well-developed sandplains with this association on BLM lands showed the affects of heavy grazing by sheep or livestock. Several BLM Sensitive and Watch species (*Asclepias stenophylla*, *Chenopodium subglabrum*, *Cyperus schweinitzii*, *Dalea villosa*, *Mirabilis hirsuta*, *Penstemon angustifolius*, and *Psoralea hypogaea*) occur on sandy substrates in or adjacent to STICOM/CARFIL communities in Carter County. Poor condition of STICOM/CARFIL communities at these sites may indicate that there is a grazing pressure on the rare plants populations.

BOTANY RESULTS

A total of eighteen Montana plant species of special concern are documented from Carter County, nine of which are on BLM-administered lands. Most of the eighteen species are Great Plains species at the western limits of their range. Three of them are species that live in this area of the Great Plains and nowhere else in the world (regionally endemic). None are appropriate to consider as federally threatened or endangered.

A status review for each of the eighteen Carter County plant species of special concern is provided in the pages which follow, including a description of the species, its geographical distribution, habitat, species biology, and other comments. This includes a compilation of observations and data collected in the course of the fieldwork, a review of statewide information, and a literature review. Statewide distribution maps are provided with the status review, and species illustrations and photos are included separately in the appendix.

Seven of the nine species that are on BLM-administered land in Carter County are currently recognized by the Montana State Office of BLM as sensitive or watch (USDI BLM 1996). Bur oak (*Quercus macrocarpa*) is the only one of the seven species with sensitive status and the rest are watch. Two of the seven species we recommend dropping because they are not likely to be found on BLM lands or because they may increase under disturbance. Two more are recommended for addition: the Visher's buckwheat (*Eriogonum visherii*) that was found on BLM land in 1997 represents the first occurrence of this regional endemic documented from Montana. It is recognized by the BLM as a watch species in the rest of its range (North and South Dakota; USDI BLM 1996), and is likewise recommended for watch status in Montana. Another Great Plains endemic, double bladderpod (*Physaria brassicoides*), was located on BLM land for the first time in 1997, and its addition to the BLM Watch list is also recommended.

Six other changes are recommended to the state list of species of special concern as a result of this project. Most of them reflect that the species are more common than previously known. A list of the eighteen Montana plant species of special concern and tallies of their records in the county and in the state are presented in Table 6: Occurrences of Montana plant species of special concern in Carter County, MT.

A map that shows all locations in the County is provided in Figure 5: Sensitive plant locations in Carter County, MT. The information that accompanies each point on BLM-administered land is provided in Element Occurrence Records (Appendix B). For the sake of brevity, we refer to the 18 species as "sensitive" in this report to indicate that they are currently being tracked as Montana plant species of special concern, whether or not they have BLM or U.S. Forest Service designation as sensitive or watch species.

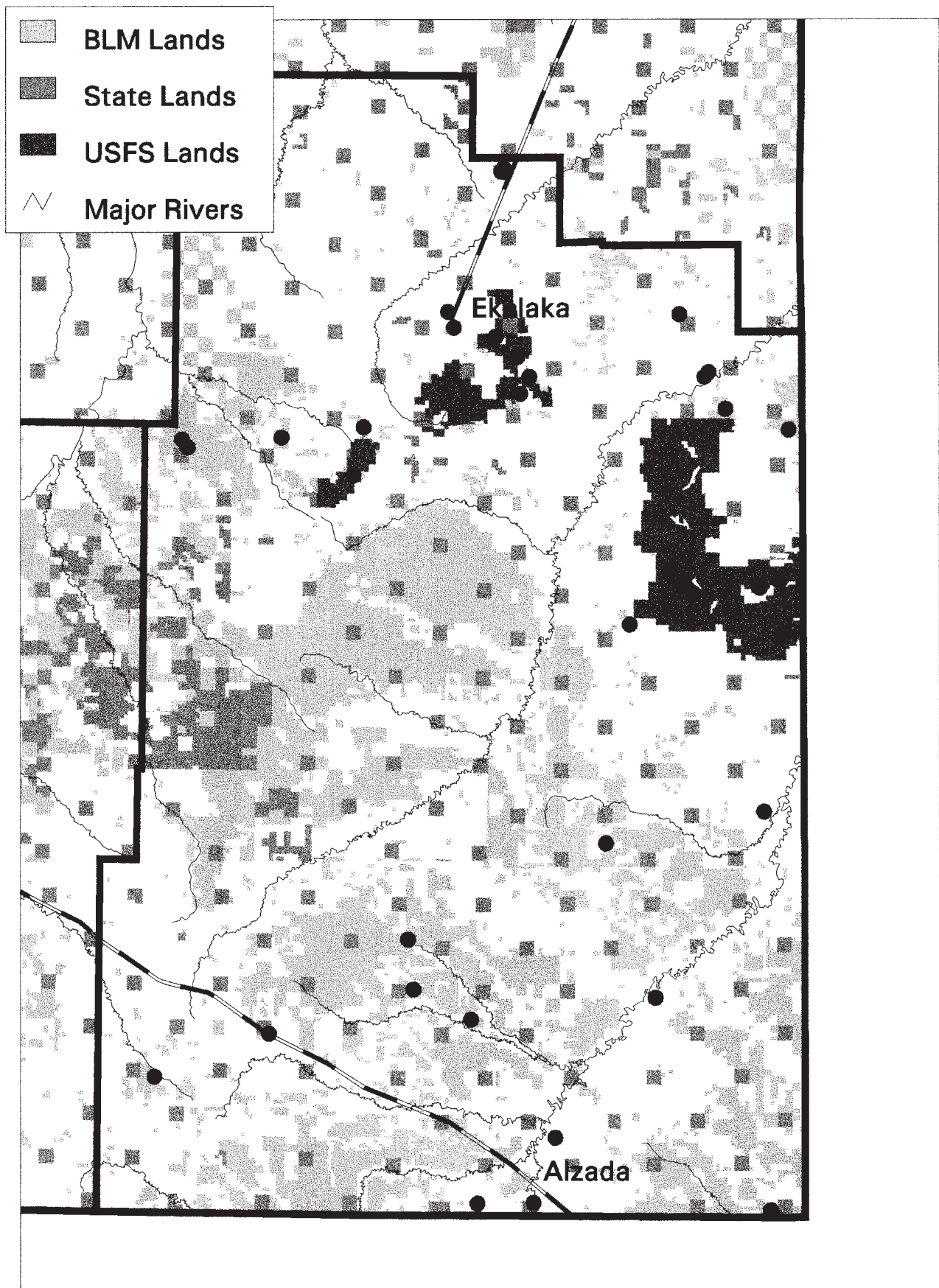
Table 6. Occurrences of Montana plant species of special concern in Carter County, MT.

Scientific name	# Carter County occurrences (# on BLM land)	# Montana occurrences (# on BLM land)	Previous BLM/MNHP status	Recommended status changes
<i>Amorpha canescens</i> Lead plant	1 historical (?)	2 historical	None/G5 SH	-
<i>Asclepias ovalifolia</i> Ovalleaf milkweed	1 (0)	1 (0)	Watch/G5? S1	Drop ñ BLM
<i>Asclepias stenophylla</i> Narrowleaf milkweed	4 (2)	6 (3)	Watch/G4G5 S1	-
<i>Astragalus barrii</i> Barris milkvetch	1 historical (?)	38 (9)	Watch/G3 S3	-
<i>Astragalus racemosus</i> Raceme milkvetch	7 (5)	8 (5)	Watch/G5T4 S1	S2
<i>Chenopodium subglabrum</i> Smooth goosefoot	1 (0)	3 (0)	Watch/G3 S1	-
<i>Cyperus schweinitzii</i> Schweinitzi flatsedge	3 (2)	6 (2)	Watch/G5S1	-
<i>Dalea villosa</i> Silky prairie clover	2 (0)	2 (0)	Watch/G5T? S1	-
<i>Eriogonum visherii</i> Visheris buckwheat	1 (1)	1 (1)	None/ none	Watch/ S1
<i>Linaria canadensis</i> Blue toadflax	1 (?)	2 (2?)	Watch/G4G5 S1	-
<i>Maianthemum canadense</i> Wild lily-of-the-valley	1 (?)	1 (0)	None/G5 S1	SH
<i>Mirabilis hirsuta</i> Hairy four-o'clock	1 (0)	4 (0)	Watch/G5 S1	Drop ñ BLM and state
<i>Penstemon angustifolius</i> Narrowleaf penstemon	8 (3)	11 (4)	Watch/G5 S2	-
<i>Phlox andicola</i> Plains phlox	3 (2)	8 (2)	Watch/G4 S1	S2
<i>Physaria brassicoides</i> Double bladderpod	4 (2)	4 (2)	None/G5 S1	Watch
<i>Psoralea hypogaea</i> Little indian breadroot	1 (1)	12(7)	Watch/G5T4? S1	S2
<i>Quercus macrocarpa</i> Bur oak	1 (portion)	1 (portion)	Sensitive/G5 S1	-
<i>Solidago ptarmicoides</i> Prairie aster	1 (0)		none/G5 S1	-

Two species are known from Carter County only by historical (pre-1950) collections and 6 other species are known mostly from Custer National Forest or Medicine Rocks State Park, but have not been located on BLM-administered land. In addition to the species reported above, additional species were noted that have been considered species of special concern in the past. For example, the species multi-stemmed goldenweed (*Haplopappus multicaulis*) is also a regional endemics confined to limited segments of adjoining Great Plains states, but it is found in large numbers, it is found repeatedly, and it is not under any apparent threat.

The compiled list of vascular plants of Carter County (Appendix C) includes a total of about 417 taxa in 70 families. Of these, 354 were observed on BLM land during the course of this study, 15 were observed only on Custer National Forest, state, or private land, and 48 were not observed but are documented from Carter County in Booth and Wright (1966). The 307 total dicots on the list are almost double the 155 shown for Carter County in Booth and Wright. That flora, which covers only dicots, has dot maps showing county distribution in Montana based on specimens at Montana State University (MONT). Further herbarium searches and field surveys would undoubtedly reveal additions to the flora of Carter County; the list presented here should be considered preliminary.

Figure 5. Sensitive Plant Locations, Carter County



Montana Natural Heritage Program, February 4, 1998

***Amorpha canescens* Pursh**
LEAD PLANT
Bean Family (Fabaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None.

Bureau of Land Management: None.

Montana Natural Heritage Program: G5 SH; Demonstrably secure globally, but known in Montana only from records generally older than 50 years.

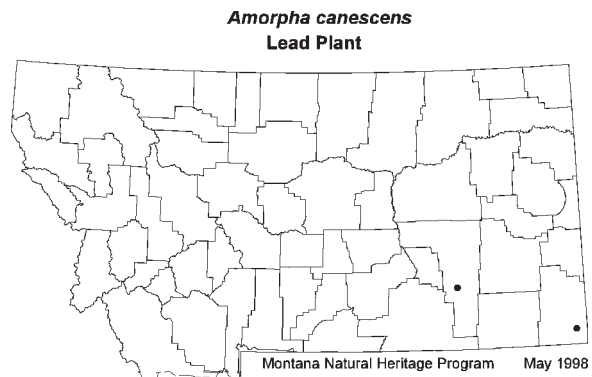
DESCRIPTION: Lead plant is a shrub with few to several, erect or ascending, simple or sparingly branched stems, 3-8 dm (1-2 ft.) high. In marginal sites, the plant may die back to near the base each year. The alternate leaves have a short petiole and 27-41 narrowly elliptic leaflets, 8-15 mm (ca. 0.5 in.) long. Foliage is covered with very dense, short white hairs, giving the plant a hoary appearance. The violet flowers are borne in dense spike-like inflorescences, 7-15 cm (3-6 in.) long, arising on long stems from the leaf axils. Each small flower has a single petal longer than the densely hairy calyx that is ca. 2 mm long. There are 10 bright orange stamens exerted beyond the petal. The glandular and hairy fruits are ca. 4 mm long and egg-shaped with a long beak. Flowering in late June-July; fruiting through summer.

Lead plant could be confused with members of the prairie-clover genus or scurfpea genus (*Dalea* or *Psoralea*), but unlike these plants, it has woody stems, it does not have leaves with conspicuous resin-like glands, and it has flowers with only one petal.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Great Plains and Midwest, from Indiana south to Texas, west to Manitoba and eastern Montana; south to New Mexico (Dorn 1984, 1992, Great Plains Flora Association 1986).

Montana distribution: Historically known from southeastern Montana by two pre-1950 collections from Carter and Rosebud cos.; also reported on a 1983 checklist for the Colstrip vicinity, Rosebud County (Coenenberg 1983) with no known collections. The latter would provide basis for changing the species rank to iS11 if documented by a collection.



Carter County distribution: Lead plant was collected in 1948 by W. E. Booth from the vicinity of Albion. Searches by Peter Lesica in 1986 failed to relocate this occurrence. Recent surveys of Carter County Custer National Forest lands (Heidel and Dueholm 1995) and BLM lands did not locate the species in the county. Much of the Albion area is in private ownership and has intact rangeland, but we have inadequate information to comment on the likelihood of it persisting in the county.

HABITAT: Lead plant occupies dry, well-drained prairies. In the central Great Plains, it is characterized as one of the most conspicuous and common shrubs of uplands (Weaver 1954). In Montana, Booth and Wright (1966) list the habitat as dry, sandy prairies. The approximate range in elevation from known collection areas in Montana is 3000-3400 ft. It is noted that the primary areas of well-drained prairie in the Albion area are on the alluvial deposits and valley margins along the Little Missouri valley.

Farther east in the Great Plains, lead plant is often the only woody plant or among the few woody plants where it grows, and does not compete with grasses because of its deep root system. It grows downstream along the Little Missouri River of North Dakota on valley benches and terraces (Heidel personal observation). In South Dakota, it is characteristically associated with the bluestem grasses, little bluestem and big bluestem (*Schizachyrium scoparium* and *Andropogon gerardii*, respectively; Johnson and Nichols 1982). These are warm-season grasses that characteristically require higher annual precipitation levels than are found in Montana, but which are widely scattered in eastern Montana, often in subirrigated conditions.

SPECIES BIOLOGY: Lead plant is a long-lived perennial. Like most of the members of the bean family, it fixes nitrogen, enhancing soil fertility. It produces prolific flowers and is insect-pollinated.

Farther east on the Missouri River, it is very common on good-condition range sites in a segment of the landscape (Heidel personal observation). But at the margins of its distribution, it is more likely to be present in low densities and population numbers.

OTHER COMMENTS: The 1922 collection label from Rosebud County noted that the species was heavily browsed by cattle and horses. It decreases under intense grazing (Great Plains Flora Association 1986, Smith 1976), while it is considered resilient to mowing and grazing under some levels or frequencies. It is considered an excellent forage of high nutritive quality and palatability (Johnson and Nichols 1982), and may be a species to feature in local and regional range plant identification events.

It is reported cultivated as an ornamental (Johnson and Nichols 1982, Barr 1983) but there is no evidence to suggest that this would explain its occurrences in Montana.

We are reasonably sure that it does not occur on BLM-administered lands in Carter County, but it may be appropriate to retain as watch because it has not been systematically surveyed in other counties where it has been collected or reported.

Asclepias ovalifolia Decaisne
OVALLEAF MILKWEED
Milkweed Family (Asclepiadaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None

Bureau of Land Management: Watch.

Montana Natural Heritage Program: G5? S1; Demonstrably secure globally, but may be critically imperiled in Montana where it is extremely rare.

DESCRIPTION: Ovalleaf milkweed is a rhizomatous perennial with solitary (occasionally 2) slender stems up to 6 dm (2 ft) high. The sap is milky. The erect to spreading, opposite leaves have petioles up to 1 cm long and broadly lance-shaped to elliptic blades, 4-8 cm (1-3 in) long, with entire margins. Leaves are moderately long-hairy beneath. 1-3 umbrella-shaped, stalked clusters of 8-20 flowers arise from the axils of upper leaves. Each greenish-white to yellow flower is 8-10 mm high and sessile or on a hairy pedicel up to 20 mm long. Flowers have 5 reflexed corolla lobes, 5-6 mm long, and 5 erect hoods, 4-5 mm long, that are rounded at the tip and surround a greenish or yellowish central column. Each hood has a conical horn inside. The erect spindle-shaped fruits are 6-8 cm (2-3 in) long and ca. 1 cm wide. Each fruit has numerous seeds, each with a light brown tuft of hairs, 18-35 mm long. Flowering in late June-early July.

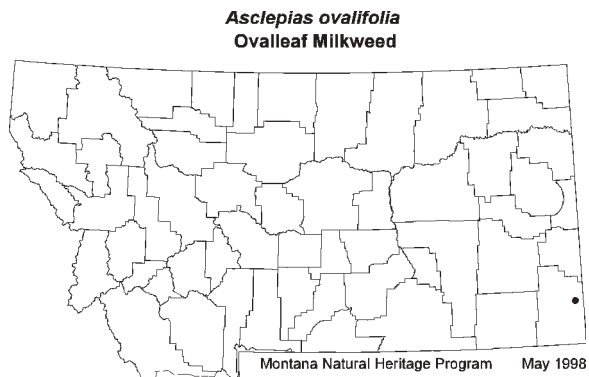
Green milkweed (*Asclepias viridiflora*) and showy milkweed (*A. speciosa*) also have broad leaves, but the former lacks horns within the hoods, and the latter has pink to purple flowers.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Northern Great Plains and Midwest, from Illinois and Manitoba west to eastern Alberta and eastern Wyoming (Great Plains Flora Association 1986).

Montana distribution: Carter County.

Carter County distribution: The species was first discovered in Montana in 1994 (Heidel and Dueholm 1995; Heidel 1996) at the southwestern end of Long Pines unit of the Custer National Forest. This is the only place it has been reported in the state.



HABITAT: The Long Pines population of *Asclepias ovalifolia* occurs on an alluvial terrace along a small drainage on the Long Pines escarpment. It is near a forest opening among widely spaced trees in a partially burned stand of ponderosa pine (*Pinus ponderosa*). The tree canopy cover is semi-open, but there is a high undergrowth vegetation cover, dominated by Kentucky bluegrass (*Poa pratensis*), western snowberry (*Symphoricarpos occidentalis*), and creeping Oregon grape (*Mahonia repens*). The soils are derived from sandstone parent material, and are a dry, brown, sandy loam. The site is at 3740-3840 ft.

Note: Most sandstone escarpment habitat in Carter County is on the Custer National Forest, but small adjoining BLM parcels, and larger tracts of BLM land in southwestern Carter County (Belcher Mountain area) may have habitat appropriate for *Asclepias ovalifolia*.

SPECIES BIOLOGY: Ovalleaf milkweed spreads by rhizomes, perhaps enabling it to survive and compete in the dense sod-forming grass and high shrub cover. This mode of vegetative reproduction means that any count of flowering stems in a population does not represent actual numbers of genetically discrete individuals and is likely to over-estimate the number of individuals.

This species, like all species of milkweeds, is adapted to cross-pollination by insects in having stigmatic glands that adhere to insect visitors, and pollen that adheres into masses (pollinia) for mass-transport. Despite the abundant flowering activity among the 400+ stems in the Long Pines population in 1994, only one plant was observed with fruit at the end of the growing season (Heidel and Dueholm 1995). This may reflect a paucity of pollinators, or else other late-season conditions that would have interfered with fruit set and development.

OTHER COMMENTS: The Long Pines population of ovalleaf milkweed is located in part of an active allotment that is in good range condition. The primary sign of habitat alteration that may be associated with livestock use is invasion by Kentucky bluegrass (*Poa pratensis*). Livestock usually avoid milkweeds (*Asclepias* spp.) and find them unpalatable. However, the valleybottom habitat is an area of concentrated use, and there is preliminary evidence at the Long Pines site to suggest that trampling may be a detriment (Heidel and Dueholm 1995).

This species evidently survived the Long Pines fire, which burned as an understory fire in the species' habitat. The fact of its persistence means only that it survives fires under the particular timing and intensity of that event, and it cannot be interpreted as a general response without additional information.

We have considered many but not all of the small, scattered BLM tracts adjoining Custer National Forest that have sandstone outcrops. Therefore, while it is unlikely to be on BLM-administered land, we have not ruled out the possibility and this survey does not provide a basis for changing its watch status.

Asclepias stenophylla A. Gray
NARROWLEAF MILKWEED
Milkweed Family (Asclepiadaceae)

CONSERVATION STATUS

U.S. Fish and Wildlife Service: None.

Bureau of Land Management: Watch.

Montana Natural Heritage Program: G4G5 S1; The species may be demonstrably secure throughout its range, but may be critically imperiled in Montana where it is extremely rare.

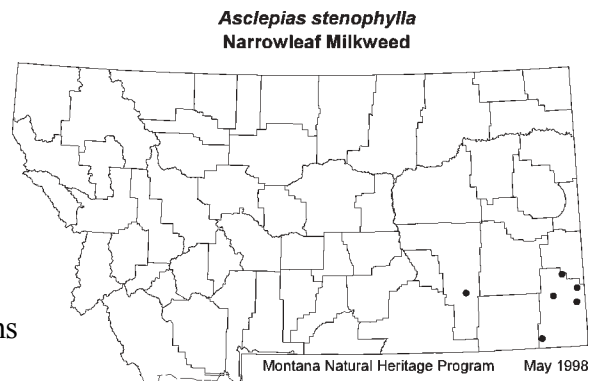
DESCRIPTION: Narrow-leaved milkweed is a perennial herb that grows from a stout underground rootstock. The stems, usually a single or pair per plant, are decumbent or upright, usually unbranched, 2-8 dm (8-30 in) long, and are filled with milky sap. The leaves are borne alternately to sub-oppositely along the stem and are linear shaped and 8-18 cm (3-7 in) long, by 1-5 mm (0.2 in) wide. The foliage is moderately to sparsely hairy. Umbrella-shaped clusters of 10-25 flowers are nearly stemless in the leaf axils of the upper half of the stem. Each greenish-white to yellow flower is 7-9 mm long and is borne on a hairy pedicel up to 1 cm long. Flowers have 5 reflexed corolla lobes and 5 erect hoods which are tri-lobed at the tip and surround a central column. The erect, spindle-shaped fruits are 9-12 cm (4-5 in) long and less than 1 cm wide. Each fruit contains numerous seeds which have white tails about 3 cm (1 in) long. Flowering in June-early July.

Both whorled milkweed (*Asclepias verticillata*) and plains milkweed (*A. pumila*) also have narrow leaves but they both have more crowded often filiform leaves usually less than 1.5 mm wide and uniformly short in length. The flower clusters are borne on stalks that are greater than 5 mm long rather than being nearly stemless in the leaf axils. The leaves of green milkweed (*A. viridiflora*), a highly variable species, are sometimes linear, but the hoods of the flowers have rounded apices. A hand lens reveals the three-lobed hoods of *A. stenophylla* that are diagnostic of the species. The middle lobe of the hood is considered to be analogous to the horn of other milkweeds (adapted from Great Plains Flora Association 1985, Dorn 1984).

GEOGRAPHICAL DISTRIBUTION

Global distribution: Great Plains and Midwest; from western Illinois west to eastern Montana, eastern Wyoming and central Colorado, south to western Arkansas and Texas (Great Plains Flora Association 1986).

Montana distribution: Known from six locations in Carter and Rosebud Counties.



Carter County distribution: The five Carter County occurrences represent the majority in the state. Most are in the northern end of the county. Prior to 1997, two populations were known in the Custer National Forest on the Chalk Buttes and Long Pines units (Heidel and Dueholm 1995), and one population was known at Medicine Rocks State Park. Two additional populations were found on BLM land in 1997, one near Mill Iron in the northern part of the county, and one in the Little Powder River drainage in the southwest part of the county.

HABITAT: All Montana populations of *Asclepias stenophylla* grow on grassy uplands with sandy soils, often with scattered *Pinus ponderosa*. It is possible that its distribution on BLM lands in the county corresponds with that of the Fox Hills Sandstone Formation (Ross et al. 1955), though there are other settings with sandy soils in the county. The grasslands represent sandy range sites typically dominated by needle-and-thread with threadleaf sedge plant associations (*Stipa comata*-*Carex filifolia* p.a.). Other dominants may include prairie sandreed (*Calamovilfa longifolia*) and little bluestem (*Schizachyrium scoparium*; syn. *Andropogon scoparius*). At the BLM sites, the populations are near the ecotones of open stands of ponderosa pine (*Pinus ponderosa*). Associated forbs include purple coneflower (*Echinacea angustifolia*), spiderwort (*Tradescantia occidentalis*), and green milkweed (*Asclepias viridiflora*), species which are characteristic of sandy soils. Known Montana sites are at 3100-3900 ft.

SPECIES BIOLOGY: All Montana populations are relatively small, the largest being those at Medicine Rocks State Park and at the Rosebud County site, with around 100 plants each. Twenty-six plants were found at the BLM Mill Iron site while only ten plants were found in the Little Powder River population. Both areas were thoroughly surveyed, indicating that these are probably small, isolated populations. All plants in these populations were in flower at the survey dates in early July. Both of the Custer National Forest populations are extremely small, consisting of just six plants in each observed in 1994. Fruit production has not been observed in Montana populations. Reproduction in these small isolated populations may be limited by pollination, as the species, like all milkweeds, is adapted to cross-pollination by insects.

OTHER COMMENTS: The habitats of the BLM populations are grazed by sheep at the Mill Iron site, and by cattle at the Little Powder River site. Some species of *Asclepias* are known to be poisonous to livestock, especially sheep, but the plants are reportedly rarely eaten if other forage is available (Great Plains Flora Association 1986). However, browsing of plants to the ground, probably by sheep, was observed at the Mill Iron site. Range condition in the vicinity of the populations was at the low end. The Mill Iron site is on a small, isolated BLM tract surrounded by private ranchlands. Due to few populations, small population size, and presence of potential threats, we recommend that current BLM Watch status be changed to Sensitive status for this species.

This is one of several sand-loving species in the county that are often found with other species of special concern where the habitat is extensive and/or in good condition.

Astragalus barrii Barneby
BARRS MILKVETCH
Bean Family (Fabaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None. It had once been considered a candidate for listing (C2), but was dropped for being more common than originally known (3C).

Bureau of Land Management: Watch.

Montana Natural Heritage Program: G3 S3; Vulnerable because of rarity, both throughout its range and in Montana.

DESCRIPTION: Barrís milkvetch is a perennial that forms low, dense mats, with prostrate or ascending stems up to 2 cm long from a woody rootcrown. Leaves have 3 narrowly lance-shaped leaflets, are 1-4 cm long; and have membranous stipules. Leaves and stems are densely covered with short white hairs. Purple or pinkish-purple flowers are borne in short stalked, narrow, open, few-flowered inflorescences. Flower petals are 7-17 mm long and the calyx is 3-5 mm long and densely covered with long, white hairs. The sparsely white-hairy pod is narrowly elliptical and 4-8 mm long and 1-2 mm in diameter. Flowering in May to early June. The timing of flowering makes early season surveys essential for locating populations of the species.

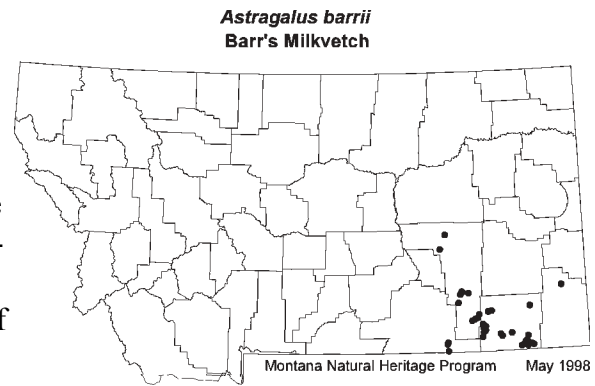
Vegetatively, Barrís milkvetch is similar to other mat forming, 3-leaflet species of the genus in Montana, tufted milkvetch (*A. gilviflorus*), summer orophaca (*A. hyalinus*), and Sweetwater milkvetch (*A. sericoleucus* var. *aretiodes*). The first two of these species overlap with Barrís milkvetch in their geographic distributions and flowering material is needed for positive identification. *Astragalus gilviflorus* and *A. hyalinus* have larger flowers with a calyx 6-16 mm, and with whitish to cream colored corollas. They also have flower stalks (peduncles) which are short (< 3.5 mm) or absent, compared to *Astragalus barrii* peduncle length (7-24 mm). *Astragalus gilviflorus* is widespread over the state and common. *Astragalus hyalinus* is occasional in Big Horn, Carbon, Rosebud and Powder River counties; locally common in the Pryor Mountains; and *A. sericoleucus* var. *aretiodes* is restricted to the Pryor Mountains.

GEOGRAPHIC DISTRIBUTION

Global distribution: Barrís milkvetch is a regional endemic known only from southeastern Montana, southwestern South Dakota, and northeastern Wyoming (Heidel and Marriott 1996).

Montana distribution: Southeastern Montana in Bighorn, Carter, Powder River, and Rosebud counties.

Carter County distribution: The occurrence record in Carter County represents a 1943 collection from Ekalaka which is cited in Barneby (1964). Field surveys in 1986 and 1989 in the vicinity of Ekalaka did not relocate the species. In the course of this study, we have ruled out the likelihood of it occurring on BLM-administered land in the vicinity of Ekalaka. We have also ruled out the likelihood of it in most of northern Carter County, but not in the whole county. The timing or extent of baseline survey in western ends of the county with potential habitat was not suited for inventorying this species. These areas may be similar to the populations along the Powder River breaks in Powder River County.



In the plant association and community type constancy/cover tables (Appendix A), mat forming 3-leaflet milkvetches were provisionally identified as tufted milkvetch (*Astragalus gilviflorus*; ASTGIL), which is many magnitudes more common as well as more widespread in distribution than Barr's milkvetch.

HABITAT: Montana habitats of Barr's milkvetch are mostly sparsely vegetated knobs and buttes, usually with dry, fine-textured, often calcareous soils. Many are situated along rivers or streams, where downcutting has exposed shale and siltstone outcrops. It appears to be a poor competitor. The species is often locally confined to specific soil types and rock formations. The highest known numbers are on silty soils of the Midway series, representing calcareous, platy, soft shale with a montmorillonitic clay component (Heidel and Marriott 1996). However, it is apparently not restricted to this series in the state.

The occupied microhabitat represents clayey and shallow clay range site associations that are sparsely vegetated and usually have scattered bunchgrass (bluebunch wheatgrass; *Pseudoroegneria spicata*, syn. *Agropyron spicatum*). The surrounding landscape varies from sparsely forested to open plains, with various plant and range associations. The known occurrences span 2950-4160 ft.

SPECIES BIOLOGY: The potential life span and population age structure for this species is unknown, though other members of the group *Orophaca* can live in excess of 25 years. Barr's milkvetch is considered prolific with fertile pods (Barneby 1964), though it has been noted that some populations and some drought years have little or no flowering activity (Heidel and Marriott 1996).

The individual plants of a population are often broadly dispersed across the landscape, with population distribution apparently related to available substrate and local outcrop patterns. There are a few populations that have been documented with over 1000 individuals total.

OTHER COMMENTS: Barr's milkvetch is known from BLM-administered lands elsewhere in its range. More complete status information is presented in Schassberger (1990) and Heidel and Marriott (1996). This study does not provide any new information for reconsidering its status.

Astragalus racemosus Pursh
RACEME MILKVETCH
Bean Family (Fabaceae)

CONSERVATION STATUS

U.S. Fish and Wildlife Service: None.

Bureau of Land Management: Watch

Montana Natural Heritage Program: G5 S1; the species as a whole is demonstrably secure globally, but may be critically imperiled in Montana where it is extremely rare. Note: This study provides a basis for changing the state rank.

DESCRIPTION: Raceme milkvetch is a coarse, herbaceous perennial with few to many erect stems, 15-70 cm (6-28 in) high, from a woody taproot and branched rootcrown. The pinnately compound leaves are 4-15 cm (2-6 in) long with 11-31 narrowly to broadly elliptic leaflets. The foliage is thinly to densely covered with short basally attached hairs. Inflorescences with 15-70 densely clustered flowers arise from the axils of the upper leaves. Nodding, whitish flowers are 16-21 mm (ca. 0.5 in) long with a partially reflexed upper petal and purplish tinged lower petals. *Astragalus bisulcatus* seen in Carter County during this study had purplish flowers, but color is variable for the species. The calyx is 8-11 mm long and glabrous (lacking hairs) or with scattered hairs. The pendent, oblong-elliptic pods have a basal stalk, 3-7 mm long, and are glabrous, triangular in cross-section; the 3 faces flat and or equal width or nearly so, and 15-30 mm (ca. 1 in) long.

Flowering in late June - early July.

The combination of coarse, erect stems, short basifixed pubescence, and pendent pods that are triangular in cross-section is diagnostic of this species in the Northern Great Plains. Manuals (Dorn 1984, Great Plains Flora Association 1986) use the character of united stipules of the basal leaves to key *Astragalus racemosus*, however, this character was not observable on Carter County plants (growing stems had apparently split the connection). Mature fruit are required to distinguish *A. racemosus* from whitish flowered forms of two-groove milkvetch (*A. bisulcatus*). Pods of the latter are flattened dorsiventrally (top to bottom) rather than trigonously; the dorsal side is convex and the ventral side is doubly grooved or depressed. Drummond's milkvetch (*Astragalus drummondii*), another coarse, whitish flowered milkvetch occurring in Carter County, differs by having foliage with long spreading hairs.

Note: We have been treating all collection records of raceme milkvetch in Montana as one variety, *Astragalus racemosus* var. *longisetus* Jones, in keeping with Lesica and Shelly (1991). However, at least one of these collections of *Astragalus racemosus* (Lesica #4565), from Carter County, has been annotated by Rupert Barneby, specialist of the genus, as *A. r.* var. *racemosus*. This variety differs from var. *longisetus* by having a shorter calyx (7.3-9 mm vs. 10-19 mm) and shorter calyx teeth (1-3.5 mm vs. 5-10 mm), and by having narrower leaves (linear to elliptic vs. broadly elliptic to ovate-oblong) (Barneby 1964).

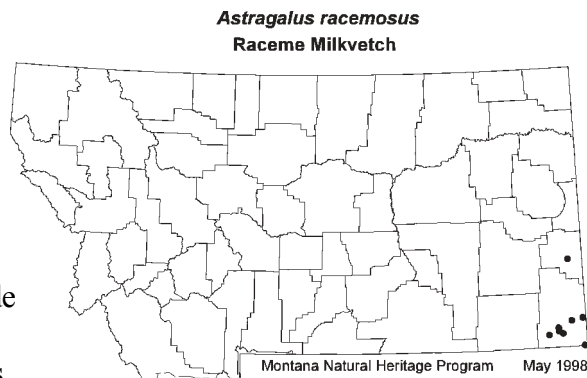
The duplicate of the annotated specimen at MONTU (Herbarium at U. of Montana) has calyx 12 mm long with teeth 7 mm long. A collection from Fallon County, Montana (Lesica #4280) has calyx 8 mm long with teeth 3 mm long. Our collections from Carter County (Vanderhorst 5695, 5713) have relatively short calyces (about 8 mm) and teeth (3-5 mm), but relatively broad basal leaflets. Plants intermediate between the two varieties are reported from Colorado, Kansas, and Nebraska (Great Plains Flora Association 1986). Further collecting and consultation will be required to determine which variety or varieties occur in Montana.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Great Plains; *Astragalus racemosus* var. *longisetus* is found in the western Great Plains in southwest South Dakota, northwest Nebraska, eastern Colorado and eastern New Mexico (Great Plains Flora Association 1986), eastern Wyoming (Dorn 1992), and eastern Montana. Note: The nominate variety has a broader and sometimes sympatric distribution (Barneby 1964), from western Minnesota to southern Saskatchewan south to the Texas panhandle (Great Plains Flora Association 1986).

Montana distribution: Carter and Fallon counties.

Carter County distribution: Prior to this study raceme milkvetch was known by one 1938 collection with uncertain location data and, more recently, from one location on state land along Highway 212 east of Hammond. In 1997, five populations were found on BLM land and an additional population was found along the roadside on private land. These occurrences are scattered across the southern half of the county, and there is a possibility that the range extends north along the Powder River breaks.



HABITAT: Raceme milkvetch is confined to and is an indicator of selenium soils (Great Plains Flora Association 1986). It usually grows on igumboi; usually in ilow sites with an abundance of alkaliî (Barr 1983). These soils with high selenium content are found locally on substrates derived from marine shales. Another selenium indicator, princeis plume (*Stanleya pinnata*), grows in the same habitat at two Carter County sites. Vegetation of the sites varies from grasslands to sagebrush steppe and greasewood communities. The largest known population with the most robust plants occurs on gentle slopes of a low relief shale ridge with an excellent quality upland *Elymus lanceolatus*/*Stipa viridula* (ELYLAN/STIVIR) grassland with eroded scabby patches supporting *Eriogonum pauciflorum* (ERIPAU) communities. This stand has among the highest diversity of forbs observed in Carter County. In contrast, high population numbers were also found in *Stipa comata*/*Carex filifolia* (STICOM/CARFIL) grassland. This population is on the edge of the contact zone between sandstone and shale substrate parent materials and is a meeting and mingling of dominance by wheatgrass (*Elymus lanceolatus* and/or *Pascopyrum. smithii*) on shale and STICOM/CARFIL on sandstone. In the breaklands at the southeastern corner of the County (Wymonkota) a few plants were also found near the contact zone of sandstone and shale outcrops where

the vegetation is a mingling of dominants from sagebrush steppe (ARTTSW/ELYLAN) and STICOM/CARFIL grassland types. Smaller populations of *Astragalus racemosus* were found in shrub dominated communities, including *Artemisia tridentata* ssp. *wyomingensis*/*Elymus lanceolatus* (ARTTSW/ELYLAN) and *Sarcobatus vermiculatus*/*Elymus lanceolatus* (SARVER/ELYLAN) habitat types. The elevation ranges from 3000-3760 ft.

SPECIES BIOLOGY: The species is considered short-lived (Barr 1983). The largest population documented to date in Montana was found in 1997 on BLM and private land above South Cottonwood Creek. It was estimated to consist of about 2,000 plants covering over 40 acres, and included many extremely robust plants with high fruit production judging from the quantity of maturing fruits observed in mid-July. Relatively high numbers (about 100 plants) were also observed at East Finger Buttes but at the time of survey in mid-August all plants observed were vegetative or had naked flower stalks, with no fruits, indicating either fruit dispersal or flower abortion. Several fruiting plants were observed along the roadside near Three Peaks, but the occurrence is on private property and was not completely surveyed. White-flowered plants with immature fruits were also observed at the northwestern end of the block of BLM-administered land lying southeast of Chalk Buttes; but verification was not possible. Relatively few plants were seen at the other 3 locations surveyed in 1997, but these were sometimes widely scattered across large areas of potential habitat, making complete survey difficult. Most of the plants in these small populations were vegetative and identification hinged on encountering a single reproductive plant.

OTHER COMMENTS: *Astragalus racemosus* accumulates selenium and may cause poisoning of livestock. The Great Plains Flora Association (1988) reports that the species is rarely eaten by livestock, however, other species of *Astragalus* are reported to cause addiction leading to ilocoism. No browsed plants were observed but all populations found were in good condition rangelands without evidence of recent livestock use. The site of the largest *A. racemosus* population has unusually high forb diversity and high cover by green needlegrass (*Nasella viridula*) indicating excellent range condition for the particular range site. It is possible that allotment ranchers keep livestock away from areas that are known to have selenium soils or time the season of use to avoid poisoning effects. The range literature does not indicate whether *A. racemosus* is an increaser or decreaser under grazing. The fact that its largest known numbers are in noteworthy range condition, and that this is a species of concern to all livestock operators, means that it warrants range management attention if not a watch status.

The number of new occurrences documented in the course of this study provides evidence for changing its state status from S1 to S2. Its status would be changed again if additional occurrences are found or if it increase with grazing in Montana.

***Chenopodium subglabrum* (S. Watson) A. Nelson**
SMOOTH GOOSEFOOT
Goosefoot Family (Chenopodiaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None.

Bureau of Land Management: Watch (USDI BLM 1996).

Montana Natural Heritage Program: G3 S1; Vulnerable globally because of rarity, and may be critically imperiled in Montana where it is extremely rare.

DESCRIPTION: Smooth goosefoot is an annual with erect, simple or highly branched stems 2-3 (8) dm (8-16 in) high. The alternate leaves are glabrous, up to 3 cm (1 in) long, have a single vein and are linear with entire margins. Flowers are small, green, and grouped in remote clusters along the branched stem. Each flower lacks petals but has 5 glabrous sepals. The 1-seeded fruit is compressed hemispheric and ca. 1-2 mm across, exposing a jet-black fruit at maturity that readily separates from the pericarp (fruit wall). Fruiting in late June-July.

Chenopodium subglabrum sometimes occurs with and is closely related to *C. leptophyllum*. They both have linear, single-veined leaves, but the latter are farinose white. *Chenopodium leptophyllum* is also distinguished by densely clustered glomerules, a relatively unbranched growth form, fruits usually 1 mm or smaller, and seeds which do not readily detach from the pericarp.

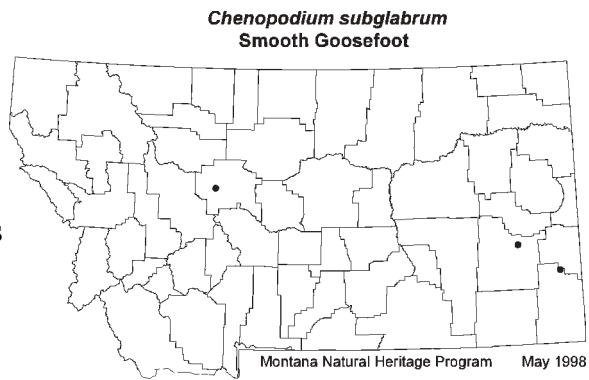
Note: Some of the species in the goosefoot genus are exotic gardening nuisances (e.g., lamb's quarters; *Chenopodium album*) and many are annuals that increase in weedy settings, but this species has not been found outside of a narrow range of natural settings where it occurs in the northern Great Plains.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Specimen review may be needed to clarify distribution. It is known from Manitoba to Alberta, south from Kansas to Utah and Nevada. It is recorded from Washington, Idaho and Oregon, but only one of the five diagnostic characteristics above are consistent with the source, Hitchcock et al. (1994). It is also reported in Gleason (1952) from western Missouri and in Crawford (1975) from Michigan. It is tracked in eight states and provinces at present (Alberta, Manitoba, Saskatchewan, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.)

Montana distribution: Small sand dune areas and to unknown extent on major eastern rivers; including three locations in Carter, Cascade, and Custer counties.

Carter County distribution: One population is known at Medicine Rocks State Park. Note: It is known from downstream on the Little Missouri River in North Dakota (North Dakota Natural Heritage Program 1990, 1993), but there are no BLM-administered lands adjoining this river in Montana.



HABITAT: *Chenopodium subglabrum* grows in extremely loose, sandy soils. In Montana, two of the populations (including the Medicine Rocks occurrence) are on sand dune habitats, and the third is on a sandbar or sandy terrace along the Powder River that might no longer be extant. The species was not found on BLM lands surveyed in 1997, and is unlikely to occur on BLM-administered lands.

SPECIES BIOLOGY: Smooth goosefoot is an annual species. It occurs in low numbers and low density (North Dakota Natural Heritage Program 1990), and its persistence is vulnerable to extreme wind or water erosion scouring events, as well as to long-term vegetation change that increases cover and competition. Like other species of the genus, it is wind-pollinated and is likely to have seeds that can survive more than one year until they germinate. It produces relatively few seeds per plant, so seedling establishment is presumed critical in species' life history.

OTHER COMMENTS: This species is very unlikely to occur on BLM-administered land in Carter County. But this study does not address BLM-administered lands throughout the state, so we do not have any new information for recommending change to its statewide status.

Noxious weeds like leafy spurge (*Euphorbia esula*) can over-run this species sandy habitat and they threaten the species elsewhere in its range. This threat is low or absent at the Medicine Rocks State Park to date. Tamarisk (*Tamarix chinensis*) is invading the locale on the Powder River where the species was collected in 1973.

This is one of several sand-loving species in the county that are often found with other species of special concern where the habitat is extensive and/or in good condition.

Cyperus schweinitzii Torrey
SCHWEINITZ FLATSEEDGE
Sedge Family (Cyperaceae)

CONSERVATION STATUS

U.S. Fish and Wildlife Service: None.

Bureau of Land Management: Watch.

Montana Natural Heritage Program: G5 S1; Demonstrably secure globally, but may be critically imperiled in Montana where it is extremely rare.

DESCRIPTION: Schweinitz flatsedge is a grass-like perennial with stems, 10-40 cm (4-16 in) high, from short, irregularly swollen rhizomes. The are 1-4 mm wide and located mostly near the base. The inflorescence is subtended by 3-6 long leaf-like bracts, some wider than the leaves. The inflorescence is made of up ascending clusters of flattened spikelets that are 5-25 mm long, borne on very short to long stalks. Flowers consist of only a small pointed scale, ca. 3-4 mm long, subtending 3 stamens and an ovary. The seed is triangular in cross-section. Fruiting in late June-August.

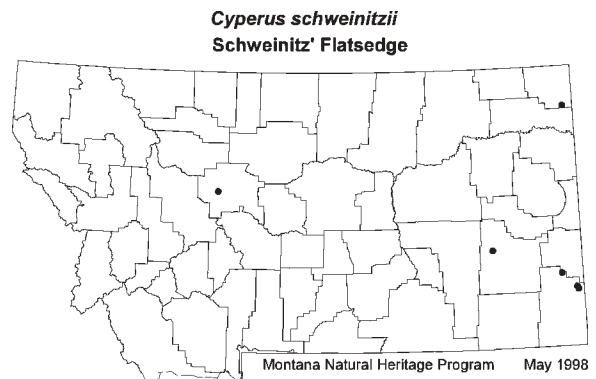
This is the only perennial CYPERUS in Montana, and the only one occurring in an upland habitat.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Great Lakes, Midwest and Great Plains, with many outliers; from Quebec to Alberta, south to New Jersey, Texas, and New Mexico (Great Plains Flora Association 1986).

Montana distribution: Scattered dune and outcrop areas and possibly along major eastern rivers; a total of six occurrences are now known from Carter, Cascade, Custer, and Sheridan counties.

Carter County distribution: Prior to 1997, *Cyperus schweinitzii* was known from one population at Medicine Rocks State Park. In 1997 two populations were found on BLM land in the vicinities of Mill Iron and Pine Hill in the north part of the county.



HABITAT: The species is restricted to sand dune habitats or colluvial slopes below eroding sandstone outcrops. The Custer County occurrence is near the Yellowstone River possibly in a similar colluvial setting.

In Carter County, the largest population at Medicine Rocks is in early successional habitat of active sand dunes. The two BLM populations are more isolated and are confined to southerly aspects below sandstone outcrops. The outcrop settings support scattered ponderosa pine and grassland mosaics with *Cyperus schweinitzii* occupying ecotones of the dominant community types with rock outcrop. Dominant grass species in these habitats include prairie reedgrass (*Calamovilfa longifolia*), little bluestem (*Schizachyrium scoparium*; syn. *Andropogon scoparium*) and needle-and-thread (*Stipa comata*). The threadleaf sedge (*Carex filifolia*) is sometimes a dominant species. Other species associated with its sandy habitat include spiderwort (*Tradescantia occidentalis*) and yucca (*Yucca glauca*).

SPECIES BIOLOGY: Carter County BLM populations are small, the Pine Hill occurrence had an estimated 100 aerial stems across about 1 acre of habitat, while the Mill Iron site had only 11 stems confined to the south side of a small outcrop. Since the plants are rhizomatous, these numbers are high estimates of the actual number of genetically distinct individuals. The population is larger at Medicine Rocks State Park (over 500 stems), and largest and far more extensive in Sheridan County in the Medicine Lake Sandhills complex (Cooper and Heidel 1998).

OTHER COMMENTS: Range conditions in the vicinity of BLM Carter County populations was at the low end, and grazed by sheep. The population areas are confined to steep or rocky areas that are less heavily grazed. No browsed plants were seen. It is difficult to assess the impact of grazing on *Cyperus schweinitzii* because the area of these populations (Mill Iron and Pine Hill vicinities) has among the longest histories of grazing in Montana. Whether the current small populations are relict numbers protected by topography, or are naturally small and limited by other habitat constraints, is uncertain. The large population at Medicine Rocks State Park is protected from grazing. Due to uncertain population trends and responses, we recommend that BLM Watch status be retained.

This is one of several sand-loving species in the county that are often found with other species of special concern where the habitat is extensive and/or in good condition.

***Dalea villosa* (Nuttall) Sprengel**
SILKY PRAIRIE CLOVER
Bean Family (Fabaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: none

Bureau of Land Management: Watch (USDI BLM 1996).

Montana natural Heritage Program: G5 S1; demonstrably secure globally, but may be critically imperiled in Montana where it is extremely rare.

DESCRIPTION: Silky prairie clover is a perennial herb with ascending, branched stems, 20-35 (50) cm (8-14 in) high, arising from red-orange roots and rootcrown. The alternate, pinnately compound leaves are 2-4 cm (ca. 1 in) long and have 11-21 linear leaflets. Foliage has numerous sunken glands and is densely long and hairy. Pink to rose-purple flowers are densely crowded in cylindrical spikes, 3-12 cm (1-5 in) long, at the ends of stems and branches. Each flower is 4-6 mm long and has 4 separate petals, a densely spreading-hairy, 5-lobed, cup-shaped calyx, and 5 stamens that are usually longer than the petals. The narrowly egg-shaped pods are 2-3 mm long and densely long-hairy. Flowering in July-August.

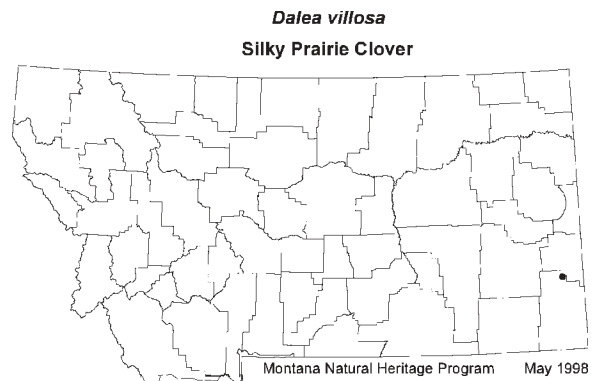
Other *Dalea* species in Montana usually have 11 or more leaflets, and are not as conspicuously hairy. Its flowers form an elongate spike and its stems are more highly-branched than other species in the genus; it may superficially resemble a shrub in its growth form. The combination of long-hairy calyx and 5 stamens further separate this from other species of *Dalea* and species of scurfpea (*Psoralea*) and leadplant (*Amorpha*).

GEOGRAPHICAL DISTRIBUTION

Global distribution: Midwest and Great Plains, from western Wisconsin and southern Manitoba to southern Saskatchewan and eastern Montana, south to Oklahoma, Texas and Colorado (Great Plains Flora Association 1986).

Montana distribution: Carter County.

Carter County distribution: Prior to 1997, one population was known from the state at Medicine Rocks State Park. Another population was found in 1997 adjoining and possibly extending onto BLM land in the vicinity of the Humbolt Hills in northeastern Carter County.



HABITAT: Throughout its range, silky prairie clover grows in very sandy substrates in habitats ranging from dunes to sandy prairies and open woodlands (Great Plains Flora Association 1986). It occupies loose, upland sandy range sites in Montana. The Medicine Rocks population is in early successional sand dune habitat in an area with little cover by ponderosa pine (*Pinus ponderosa*). The sparse vegetation is dominated by needle-and-thread (*Stipa comata*). The BLM Watch species, Schweinitzi flatsedge (*Cyperus schweinitzii*) is an associate. The Humbolt Hills site is a small blowout between isolated sandstone outcrops with associated species including prairie sandreed (*Calamovilfa longifolia*) and the BLM Watch species, narrowleaf penstemon (*Penstemon angustifolia*).

SPECIES BIOLOGY: The species is a long-lived perennial that is adapted for insect pollination. It is aptly named as silky for the dense hairs that lie flat against the leaflets that give it a silky sheen, and are adaptation to its dessicating habitat.

The Medicine Rocks population has been estimated at over 200 plants; noted in 1992 as having notable vigor and many stems. The Humbolt Hills occurrence consisted of more than 10 plants beginning to flower in early June, but a complete survey was not conducted.

OTHER COMMENTS: The Medicine Rocks population was noted as having notable vigor and multiple stems in 1992, the year following wildfire. The species is palatable to livestock and is generally considered to be a decreaser (Smith 1976). The Humbolt Hills population is at the edge of oil field development, but the single suitable spot where it was noted was not affected by the associated oil field roads and facilities.

Survey of BLM and State land in the Humbolt Hills is needed to determine the extent of the *Dalea villosa* populations there. It may warrant consideration as a watch species. No new information is available from BLM lands out of this study so there is no basis for considering a status change. This is one of several sand-loving species in the county that are often found with other species of special concern where the habitat is extensive and/or in good condition.

***Eriogonum visher* A. Nelson**
VISHER'S BUCKWHEAT
Buckwheat Family (Polygonaceae)

CONSERVATION STATUS

U.S. Fish and Wildlife Service: None. It was formerly listed as Category 2 (USDI Fish and Wildlife Service 1993), however, listing of this category was discontinued by the service in 1996 (USDI Fish and Wildlife Service 1996). Prior to that, a South Dakota status report on the species (Ode 1987) had recommended removing it from consideration (3C).

Bureau of Land Management: None. Watch status is recommended, as is consistent with BLM status in adjoining states.

Montana Natural Heritage Program: G3 S1; Vulnerable due to rarity throughout its range. It did not have a state rank prior to this study, in which it was documented for the first time in the state.

DESCRIPTION: Visher's buckwheat is an annual with a slender taproot and much-branched single stem, 15-25 cm tall. Leaves are glabrous, in a basal rosette, the blades ovate to reniform, 15-20 mm long. Bracts of the inflorescence are elliptic, involucre are on slender peduncles or sessile in an erect or spreading inflorescence. Flowers are 1-few per involucre, yellow. Flowering in late June-July.

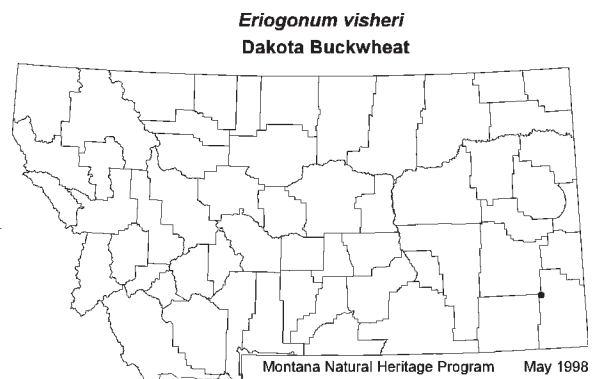
Readily distinguished from the other two annual species of *Eriogonum* in Montana; annual buckwheat (*E. annuum*) has cauline (stem) leaves rather than a distinct basal rosette, and nodding buckwheat (*E. cernuum*) has strongly reflexed involucral peduncles rather than an erect to spreading inflorescence.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Visher's buckwheat is a regional endemic known only from western South Dakota, southwestern North Dakota, and now southeastern Montana (Heidel and Dueholm 1995, Ode 1987, Vanderpool 1993).

Montana distribution: Visher's buckwheat was found for the first time in the state during his study. No other sites are known for the species in Montana.

Carter County distribution: The single known population is located on BLM land in the badlands along the Powderville Road, near the western edge of the county.



HABITAT: Throughout its range, Visher's buckwheat is restricted to sparsely vegetated, highly erodible sedimentary outcrops with badlands topography. In North and South Dakota, the species has been found on at least three geologic formations, the Hell Creek formation, where it is most abundant, a phase of the Pierre formation, and a formation in the White River group (Ode 1987, Vanderpool 1993). The Carter County, Montana population is in badlands of the Hell Creek Formation. At the Carter County site, all plants in the population were confined to dense clay alluvial outwash flats at the bottoms of eroded shale mounds, but elsewhere the species also occupies mid- and upper-slope positions in badlands. Ode (1987) characterized the growing substrates of *Eriogonum visheri* in South Dakota as heavy clay textured entisols, sodium affected, and nutrient poor, with low organic matter, low infiltration rates, and high shrink-swell potential. Few plants are adapted to these harsh conditions, and vegetation is sparse. The soils at the Montana site were derived from eroding bentonite and were vesicular silt.

The habitat of the Montana population was sparsely vegetated, with over 90% exposed bare ground. Commonly associated plant species at the Montana site, included: shadscale (*Atriplex confertifolia*), Wyoming big sage (*Artemisia tridentata* ssp. *wyomingensis*), leafy musineon (*Musineon divaricatum*), white prairie onion (*Allium textile*), thick-spiked wheatgrass (*Elymus lanceolatus*), bottlebrush squirreltail (*Sitanion hystrix*), winterfat (*Kraschnekovia lanata*), desert evening-primrose (*Oenothera cespitosa*), and Gardner's saltsage (*Atriplex gardneri*).

SPECIES BIOLOGY: The Montana population was discovered in early June, exceedingly early in the flowering stage. A complete survey was conducted in mid-July when most plants were in full flower. A total of about 1,000 plants were estimated in 4 subpopulations covering a total of about 40 acres across less than 1 mile of badlands front. The population is centered around and straddles the Powderville Road. This population number is relatively high while site acreage is relatively low compared to average size estimates of South Dakota populations (Ode 1987). High plant densities may reflect favorable growing conditions during the relatively cool, wet growing season of 1997. Populations of annuals often undergo major fluctuations in response to climate, and may remain dormant as seedbanks in unfavorable years.

OTHER COMMENTS: The Montana population of *Eriogonum visheri* lies within rangeland grazed by cattle and horses. Much of it is situated near the upper end of a pasture fenceline, so its distance from water may limit the levels of use. The associated vegetation is relatively sparse for attracting livestock to the immediate area of the population. Though most plants were in positions at the base of slopes readily accessible to livestock, no browsed or trampled plants were observed. Elsewhere in its range, its outwash habitat may be trampled with early-season livestock use, affecting its suitability for species' seed germination.

Ode (1987) identified invasion of habitat by exotic weeds, summer cypress (*Kochia scoparium*) and Russian thistle (*Salsola iberica*), as a primary potential threat to populations in South Dakota. Neither of these was observed at the Montana population site, but cheatgrass (*Bromus tectorum*), Japanese brome (*Bromus japonicus*), and yellow sweetclover (*Melilotus officinalis*) are locally abundant weeds that may have potential for invading the population area. This regionally endemic species is recommended for addition to the BLM watch list in Montana, consistent with its recognition elsewhere in its range, because land management actions affect weed populations.

***Linaria canadensis* (L.) Chaz. var. *texana* (Scheele) Pennell**
BLUE TOADFLAX
Figwort Family (Scrophulariaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None.

Bureau of Land Management: None.

Montana Natural Heritage Program: G4G5 S1; Probably secure on a rangewide basis, but may be critically imperiled in Montana where it is extremely rare.

DESCRIPTION: Blue toadflax is a slender annual with erect, unbranched stems, 1-5 dm (4-20 in) tall. There is a rosette of prostrate stems at the base; the leaves of which are narrowly oblong, 5-10 mm long, and opposite or in whorls of 3. Stem leaves are narrower; the lower are opposite or in whorls of 3, becoming alternate above. Foliage is glabrous, often with a thin, bluish, waxy coating. Short-stalked flowers are borne in an elongating, spike-like inflorescence. The snapdragon-like blue flowers, 8-12 mm long, have 5 sepals and a 2-lipped corolla. The lower lip is horizontal and 3-lobed, while the upper is 2-lobed and erect. There is a linear, down-curved spur, 2-11 mm long, at the base of the corolla. The fruit is a globose, many-seeded capsule, 2-4 mm high. Flowering in May-June.

The blue, spurred flowers and basal rosette of prostrate stems are diagnostic.

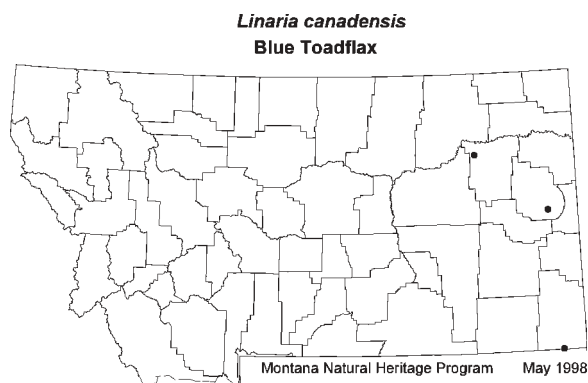
Current taxonomic treatments regard this as a distinct species, *Nuttallanthus texanus* (Scheele) D. A. Sutton. There are no other closely related species or varieties in the state. It is not to be mistaken by its common name with the exotic species, Dalmatian toadflax (*Linaria dalmatica*); treated in a separate genus by this taxonomic revision.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Eastern 2/3 of the United States, southeastern Canada, northern Mexico, and along the Pacific Coast from British Columbia south to Baja (Great Plains Flora Association 1986).

Montana distribution: Two occurrences are known from eastern Montana in Carter and Dawson counties.

Carter County distribution: The species was collected in 1986 by Peter Lesica from the Alzada Oaks in the vicinity of Sheldon Creek (Section 32).



There are stands of oak (*Quercus macrocarpa*) on both BLM and private land in this section, and precise location of the population is not known. The small BLM tract in section 32 was not visited in 1997. Habitat matching the label description on BLM land in adjoining section 31 was surveyed in 1997, but *Linaria canadensis* was not found, nor was the species found elsewhere in the county.

HABITAT: Throughout its range, *Linaria canadensis* commonly grows in sandy soils (Great Plains Flora Association 1986, Hitchcock and Cronquist 1973), but the Alzada Oaks population is on clay derived from Mowry shale. Several plant species and communities typically found in sandy habitats follow this pattern, for example both ponderosa pine (*Pinus ponderosa*) and prairie sandreed (*Calamovilfa longifolia*) are community dominants on both shale and sand substrates in Carter County.

The vegetation in the same section as the occurrence is woodland with a mixture of Rocky Mountain juniper (*Juniperus scopulorum*), bur oak (*Quercus macrocarpa*), and ponderosa pine (*Pinus ponderosa*). Associated forbs include the annuals Torrey's cryptantha (*Cryptantha torreyana*), white-stemmed mentzelia (*Mentzelia albicaulis*), bushy mentzelia (*Mentzelia dispersa*) and six-weeks fescue (*Vulpia octoflora*). Undergrowth in this oak woodland is sparse, but with a high diversity of annuals: eight species were found in a 1/10 acre plot (see discussion of *Quercus macrocarpa*/*Juniperus scopulorum* in the ecology section of this report). The bentonitic substrates of these woodlands are droughty and have high shrink-swell potential, thus inhibiting growth of many perennial forbs. Many annuals are adapted to the low levels of competition created by severe conditions, and survive these conditions by remaining dormant as seeds in unfavorable years or times of the season.

SPECIES BIOLOGY: In June of 1986 when it was collected, the population was estimated to consist of 100-1,000 plants in flower and with fruit. Populations of annuals often undergo dramatic fluctuations in response to climate, and may remain dormant as seedbanks in unfavorable years. Blue toadflax is a winter annual (Great Plains Flora Association 1986), thus seed germination and seedling development are most affected by soil moisture availability in the fall.

OTHER COMMENTS: Occurrence of *Linaria canadensis* on BLM land in Carter County has not been confirmed. BLM Sensitive status of *Quercus macrocarpa* potentially provides some protection of potential habitat for *Linaria canadensis* in Carter County. Conservation management of BLM oak woodlands as rare native plant associations will provide more protection for native understory plant species. The primary threats to these communities are livestock grazing, bentonite mining and associated roads, and the weed infestations that are potentially facilitated by these activities. Native annuals are often adapted to disturbance, but these events also promote introductions of exotic species, which may be more competitive. Lacking information on precise location, land ownership, and population viability of the Alzada oaks population, retention of current BLM Watch status of *Linaria canadensis* is appropriate.

***Maianthemum canadense* Desf. var. *interius* Fern.**
WILD LILY-OF-THE-VALLEY
Lily Family (Liliaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None

Bureau of Land Management: None

Montana Natural Heritage Program: G5 S1; in reviewing its state rank, we have determined that it is more appropriately ranked iSHñ known only from historic records.

DESCRIPTION: Wild lily-of-the-valley is a rhizomatous, perennial herb with sparsely hairy zigzag stems that are 8-20 cm high. The 2-3 elliptical leaves are ca. 8-20 cm long and have a shallow basal lobe or short petiole that partly surrounds the stem. The small, white flowers are borne in a tightly branched terminal inflorescence. The flowers have 4 stamens and 4 narrow, undifferentiated perianth segments, or tepals, that are ca. 2 mm long. The ovary matures into a red, 1-2 seeded berry that is ca. 3 mm wide. Flowering in June.

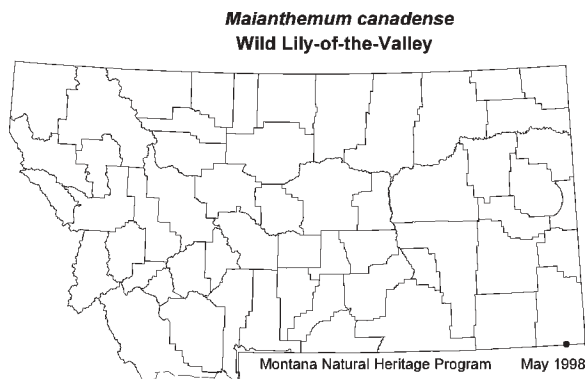
Species of *Smilacina* (*Maianthemum*) and *Disporum* have more leaves and much larger fruits. Both genera have six tepals and six stamens.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Southern Canada to North Carolina and west to Montana and Wyoming.

Montana distribution: Carter County

Carter County distribution: There is only one record from the county, a collection in 1948, from the Little Missouri River south of Alzada.



HABITAT: It is a plant of deciduous forest, woodlands and clearings. At the edge of its range in adjoining states it is known from oak and aspen woodlands.

SPECIES BIOLOGY: Unknown in Montana.

OTHER COMMENTS: This species has not been sought outside of BLM lands. It seems unlikely that this species could survive the encroachment of tall exotic grasses, which appears to be pervasive in area valleybottoms.

***Mirabilis hirsuta* (Pursh) MacM.**
HAIRY FOUR-O'CLOCK
Four-O'Clock Family (Nyctaginaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None

Bureau of Land Management: Watch

Montana Natural Heritage Program: It was ranked G5 S1 on the most recent state list (Heidel 1997); demonstrably secure globally, but may be critically imperiled in Montana due to extreme rarity. During the 1997 field season, new information was gathered that provided a basis for changing its rank to SU; status unresolved as vulnerable, no longer tracked as a state species of special concern, moved instead to the watch list.

DESCRIPTION: Hairy four-o'clock is a perennial herb from a stout taproot topped by a branched root crown. Stems are usually unbranched and erect, stand 2-12 dm tall, and lower stems are densely-covered by long, multicellular hairs. The opposite leaves lack, or have short (< 5 mm) petioles, and have blades, 2-12 cm long, which are variable in shape and vestiture, ranging from lance to egg to diamond shaped, and from long to short hairy or rarely nearly hairless. Five lobed, greenish to purplish tinged, calyx-like involucre, 4-10 mm long, are borne terminally and in leaf axils. Each involucre encloses usually three flowers. The flowers lack corollas but have pale pink to purplish red, tubular corolla-like calyces, 8-12 mm long, and 3-5 exerted stamens. As fruits mature, the calyces harden around them to form a five ribbed, roughened or tuberculate, olive to brown, densely to sparsely hairy accessory fruit, 4-5 mm long. Flowering in July-early August.

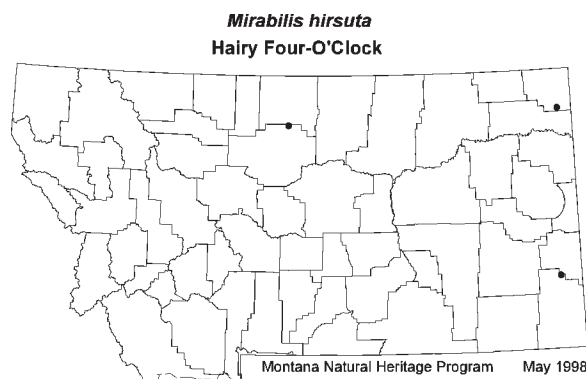
Mirabilis hirsuta is distinguished from other Montana species in the genus by having lower stems hairy with long multicellular hairs and leaves which lack or have only short petioles. Mature fruits are desirable for positive identification.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Wisconsin to Manitoba and eastern Montana, south to Missouri, Louisiana, Texas, and New Mexico, apparently rare across much of its range (Great Plains Flora Association 1986).

Montana distribution: Carter, Choteau, and Sheridan counties.

Carter County distribution: There is only one record from the county, a collection in 1973, from Medicine Rocks State Park.



HABITAT: The collection label does not give habitat information. Medicine Rocks State Park is a localized area of sandstone outcrops, sand dunes, and sandy prairie with scattered cover of open ponderosa pine woodlands. The park hosts an extremely high diversity of sand loving plants, including six additional BLM watch species. Throughout its range, *Mirabilis hirsuta* grows in a broad variety of habitats and soils (Great Plains Flora Association 1986).

SPECIES BIOLOGY: Species of the four-o'clock genus in Montana are usually found in very low numbers with a sporadic distribution.

OTHER COMMENTS: In Sheridan County, the species occurs on glacial till, in contrast to the unglaciated sand plain site in Carter County. It was found there in a separate 1997 study, where it appeared to have low habitat fidelity, occurring accidentally in a variety of native range settings, possibly associated with disturbance. While this species is only known from four records in the state, this ecological amplitude and low fidelity to natural conditions are taken as basis for changing its state rank to S2S3 (possibly on the border between imperiled or vulnerable) and moving it to the watch list.

***Penstemon angustifolius* Nutt. ex Pursh**
NARROWLEAF PENSTEMON
Figwort Family (Scrophulariaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None

Bureau of Land Management: Watch

Montana Natural Heritage Program: G5 S2; demonstrably secure globally, but may be imperiled in Montana where it is rare.

DESCRIPTION: Narrowleaf penstemon is a perennial herb with 1 or occasionally more erect stems, 15-45 cm (6-18 in) tall, from a taproot surmounted by a branched, woody crown. Basal leaves, 4-9 cm (1-4 in) long, are strap or narrowly lance shaped with short petioles and entire margins. The opposite stem leaves are just as long but lack petioles. Foliage is glabrous, somewhat thickish, and often covered with a thin coat of bluish wax. The inflorescence consists of clusters of several short-stalked flowers in the axils of the reduced upper leaves. The tubular corolla is flared and 2-lipped at the mouth, 14-20 mm long, and pink to lavender or most often bright blue, and glabrous externally. The 5 narrowly lance-shaped calyx segments are 4-8 mm long, and have a narrow white margin. The 4 anthers are glabrous. Flowering in May-June.

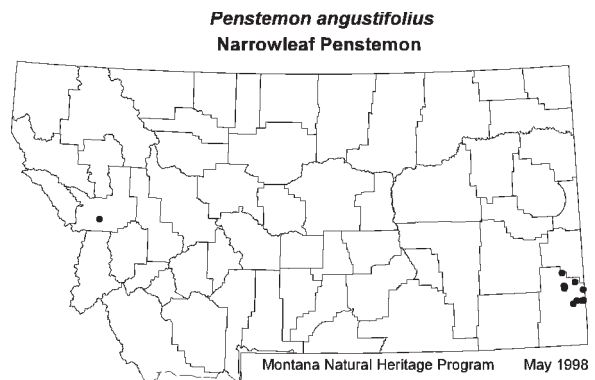
The only other species of *Penstemon* in southeastern Montana with a glabrous corolla are shining penstemon (*P. nitidus*) and large beardtongue (*P. grandiflorus*), but neither have linear leaves.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Great Plains; North Dakota to Montana, south to Arizona, New Mexico, and Oklahoma (Great Plains Flora Association 1986).

Montana distribution: There are now 12 records known from the state. All recent collections are from Carter County. Pre-1950 collections were taken from Dawson and Missoula Counties; the latter is a highly disjunct occurrence at the west end of the state that is recommended for verification.

Carter County distribution: Nine populations are documented from northern Carter County. One population is at Medicine Rocks State Park, five populations are on the Custer National Forest in the Ekalaka Hills and Long Pines, two populations are on BLM land peripheral to the Ekalaka Hills and Long Pines National Forest units, and one is on private land directly adjoining BLM land in the Humbolt Hills.



HABITAT: In Carter County, *Penstemon angustifolia* grows in sandy substrates of sandhills and prairie slopes associated with sandstone-capped buttes and outcrops. It usually grows in microhabitats with sparse vegetation, such as in blowouts or other localized erosion features within grassland communities, sometimes with scattered ponderosa pine. Dominant grasses and sedges of the patchy matrix communities include blue grama (*Bouteloua gracilis*), prairie sandreed (*Calamovilfa longifolia*), threadleaf sedge (*Carex filifolia*), and little bluestem (*Schizachyrium scoparium*; syn. *Andropogon scoparius*). Common associated forbs include sagewort (*Artemisia campestris*), showy sunflower (*Helianthus rigidus*), hairy goldenaster (*Heterotheca villosa*), and western spiderwort (*Tradescantia occidentalis*; Heidel and Dueholm 1995).

SPECIES BIOLOGY: Population numbers of the seven Carter County populations found in 1994 ranged from 14 to about 60 plants, and populations were described as multi-aged and healthy. Only one live plant and one dead plant were located at the BLM Belltower Butte population in 1996, and no plants could be found at the site in 1997. The species was common at Medicine Rocks State where population numbers are in the hundreds.

ASSESSMENT CONSIDERATIONS: Although populations were small and often confined to isolated, ephemeral microfeatures, no immediate threats to populations were identified by 1994 surveys, and the species was recommended dropped from further consideration as a special status plant by the Custer National Forest (Heidel and Dueholm 1995). Location of two additional Carter County occurrences in 1996 and 1997 further demonstrate a broad distribution of *Penstemon angustifolia* in sandy habitats scattered across the landscape of northeastern Carter County. The species appears to be favored by small-scale disturbances, is thought to be unpalatable (Heidel and Dueholm 1995), and is apparently compatible with moderate levels of livestock grazing. In spite of this, we recommend retention of BLM Watch status for the species because the total number of plants documented in Montana remains extremely low, and occurrences outside Carter County are based on old collections.

This is one of several sand-loving species in the county that are often found with other species of special concern where the habitat is extensive and/or in good condition.

***Phlox andicola* Nuttall ex A. Gray**
PLAINS PHLOX
Phlox Family (Polemoniaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None

Bureau of Land Management: Watch

Montana Natural Heritage Program: G4 S1; apparently secure globally, but may be critically imperiled in Montana where it is extremely rare. Results of 1997 studies provided a basis for changing the state rank.

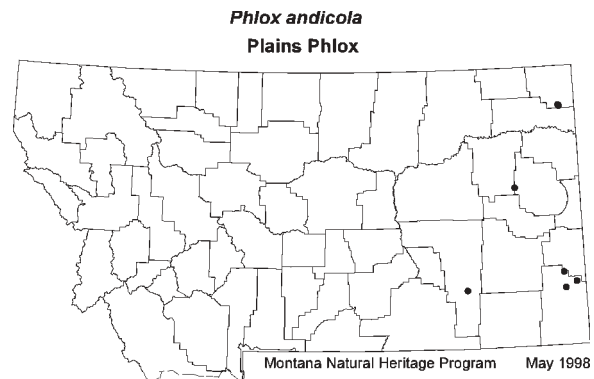
DESCRIPTION: Plains phlox is a perennial herb with loose tufted stems that are 4-10 cm (1-4 in) high, sometimes forming mats, and arising from creeping rhizomes. The 5-8 pairs of opposite, linear leaves have prominent midveins, whitish bases and are 10-25 mm long, ca. 1 mm wide, and come to a sharp point. Foliage is glabrous to sparsely hairy and the stem is distinctly white. The 1-5 flowers are white to pale pinkish or blueish, with a tubular corolla 12-15 mm long, and 5 spreading, well-rounded lobes, 6-9 mm long. The loose inflorescence is borne at the stem tips. There are usually 5 stamens and a single style, which is 5-9 mm long, with a 3-lobed stigma. The calyx is 6-11 mm long, tubular with 5 herbaceous, hairy, pointed lobes (costae) which are separated by whitish membranes, and with a tangle of pubescence along the lobes. The calyx is shorter than the corolla. Flowering in May-early June.

Alyssum-leaved phlox (*Phlox alyssifolia*) has 2-5 mm wide, more elliptic leaves. Hood's phlox (*Phlox hoodii*) has usually shorter leaves (less than 10 mm long) and, on the average, narrower leaves and smaller corolla tube and calyx. The latter also has calyx length about equaling the corolla tube length. Dimensions of the largest *P. hoodii* specimens may overlap with those of the smallest *P. andicola* specimens. Flowering material is needed for definitive identification.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Great Plains; from southwest North Dakota to southeast Montana, south to northwest Kansas and eastern Colorado (Great Plains Flora Association 1986).

Montana distribution: Plains phlox has been collected from six locations in Carter, Dawson, Rosebud and Sheridan counties. It is reported from Wibaux Co. in Lesica and Shelly (1991) but a voucher specimen has not been located.



Carter County distribution: Three populations are documented in the county. These are at Medicine Rocks State Park and on BLM and Custer National Forest lands in the Ekalaka Hills, including a tract of BLM and adjoining USFS-administered lands.

HABITAT: Plains phlox occupies a wide range of habitats in the center of its range, including sparsely-vegetated outcrops, sandplains, and heavy alkaline clays (Barr 1983). In Montana, it is known mainly from sandy substrates that support grasslands and scattered ponderosa pine, often associated with sparsely vegetated erosion microfeatures such as dunes and blowouts. It is also found in open, sandy pine woodland and openings in the Ekalaka Hills. Like hairy four o'clock, this species is known from both Sheridan County sandhills and on nearby glacial substrate. Unlike the former, its local pattern of distribution suggested that it had been a survivor of past disturbances rather than having colonized in their wake.

The Carter County Ekalaka Hills population on BLM land is a sparsely vegetated slope with scattered ponderosa pine (*Pinus ponderosa*) and skunkbush sumac (*Rhus trilobata*). This population and the second Ekalaka Hills population also extend into grassland openings, and into open pine woodland.

SPECIES BIOLOGY: The plains phlox, like other prairie phlox species, often lives to a great age, and has very deep, woody roots (Barr 1983). Prairie phlox species can reproduce by rhizomes as well as by seeds, and are generally adapted to insect-pollination.

The Medicine Rocks population of plains phlox was estimated to consist of over 1,000 plants, the Rosebud County occurrence was estimated to consist of about 10,000 plants, and the species was described as locally common at the Dawson County site. The Sheridan County occurrences were documented in late June relatively late for survey and population estimate purposes, but the species was recurrent in vegetation plots. In Carter County, a small population on Horse Creek was documented, the extent of the Ekalaka Hills occurrence was expanded significantly, and a separate occurrence in open woodland was found in the Ekalaka Hills with over 100 plants.

OTHER COMMENTS: Montana populations are in sparsely vegetated areas that receive little use by livestock, and the low growing form of *Phlox andicola* makes it resistant to browsing. The species appears to be adapted to small-scale disturbance. Given the large size of some Montana populations, its distribution across at least four counties, and its close resemblance to *Phlox hoodii*, it seems likely that *Phlox andicola* is more widespread than current records suggest. It is characterized as infrequent on dry prairies and plains in western South Dakota (Van Bruggen 1985). It is likely that more early-season surveys will provide new records of this species, though we recommend maintaining its current BLM watch status until additional occurrences are documented. The number of new occurrences documented in the course of recent studies provides evidence for changing its state status from S1 to S2. This is one of several sand-loving species in the county that are often found with other species of special concern where the habitat is extensive and/or in good condition.

***Physaria brassicoides* Rydberg**
DOUBLE BLADDERPOD
Mustard Family (Brassicaceae)

CONSERVATION STATUS

U.S. Fish and Wildlife Service: None

Bureau of Land Management: None

Montana Natural Heritage Program: G5 S1; demonstrably secure globally, but may be critically imperiled in Montana where it is extremely rare. The global rank is recommended for review because it may have been developed without due regard to the current taxonomic treatment and associated distribution information.

DESCRIPTION: Double bladderpod is a perennial herb that forms a basal rosette surmounting a branched crown and large taproot. Basal leaves, 2-8 cm (1-3 in) long, are spoon-shaped, often with wavy margins, and have long, somewhat winged petioles. Numerous stems, which ascend from the rosette, are 2-17 cm (1-6 in) long, with few, small (1-2 cm long), alternate, broadly lance-shaped leaves. Foliage throughout is covered with silvery, star-shaped hairs. The flowers are borne on pedicels at the top of the stems in a narrow inflorescence that elongates as the fruit matures. Each yellow flower has 4 separate petals, 9-12 mm long, 4 separate sepals, six stamens, and a single pistil. The bladderlike, inflated fruits (siliques) are 1-2 cm long and at least as wide, and have two chambers (locules) separated by a membranous partition (replum) which is narrow (1 mm wide) and constricted towards the middle and obtuse at the apex. The silique is heart shaped (more indented at the top than at the bottom where the two chambers meet). There are two ovules in each fruit chamber and the style is 4-5 mm long. Flowering in May-early June, fruiting in June-early July.

Physaria brassicoides is distinguished from other bladderpods primarily by fruit characters (more constricted above than below, 2 ovules per locule, and narrow, linear-shaped replum). The only other bladderpod likely to occur in Carter County is the common bladderpod (*P. didymocarpa*; if indeed their ranges overlap ñ see below). The latter has fruits that are about equally constricted above and below (dumbbell-shaped), with 4 ovules per locule. Often ovules will abort so number of seeds is not a reliable diagnostic character. Number of ovules can be determined by number of funiculi (the tiny pegs which attach the ovules to the margin of the replum), which are persistent even if ovules abort.

GEOGRAPHICAL DISTRIBUTION

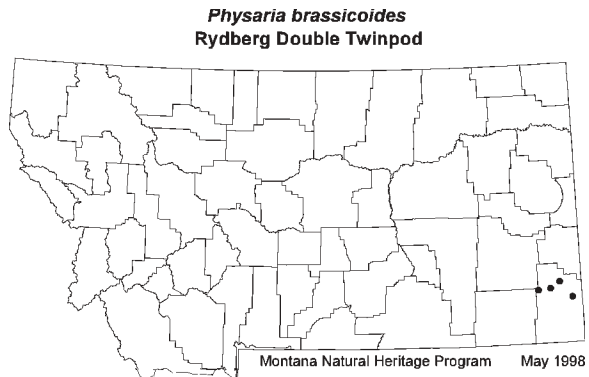
Global distribution: Western Great Plains; from western North Dakota to southeastern Montana, south to western Nebraska and eastern Wyoming (Mulligan 1967, Rollins 1993, Dorn 1992, Heidel 1996).

Note: The Great Plains Flora Association (1986) recognize just one species of bladderpod, *Physaria brassicoides* Rydb., in the Great Plains, and treats *P. didymocarpa* (Hook.) A.Gray as a synonym. It cites a Pacific Northwest and Rocky Mountain distribution for the taxon and indicates

that it may have 3 ovules per locule. This broad interpretation does not agree with the most recent treatment by Rollins (1993) which recognizes these taxa as separate, or the earlier taxonomic research of Mulligan (1967). We recognize these treatments in which *P. brassicoides* is endemic to the Great Plains.

Montana distribution: Dorn (1984) listed *Physaria brassicoides* as expected in southeast Montana but it was not verified in the state until 1994 when it was collected from Carter County by Keith Dueholm (Heidel and Dueholm 1995). To date, all known Montana occurrences are in Carter County.

Carter County distribution: Two locations were found in 1994 on the Custer National Forest in the Ekalaka Hills and the Long Pines units (Heidel and Dueholm 1995). In 1997 the species was collected twice from BLM land in northeastern Carter County in the vicinity of Chalk Buttes (Newberry Knob) and in the badlands out the Powderville Road on the western edge of the county.



HABITAT: Rollins (1993) describes habitat throughout its range as bare hillsides, dry gravel and clay soil, badlands, clay knolls and banks. All Montana populations of *Physaria brassicoides* occur on sparsely vegetated, steep, eroding, south-facing slopes of highly dissected breaklands and badlands. Substrate parent materials are both sandstone and shale. Three of the sites are at the contact zone of sandstone overlying shale, with both parent materials influencing topography and erosion processes; the upper horizons at these sites are sandy. The Powderville Road site is on the sides of gullies eroded in soft shale. These eroding slopes do not support stable vegetation communities and have 80-90% exposed substrate. Immediately associated plant species at two or more sites include the shrubs skunkbush sumac (*Rhus aromatica*) and yucca (*Yucca glauca*), the grasses indian ricegrass (*Oryzopsis hymenoides*) and little bluestem (*Schizachyrium scoparium*; syn. *Andropogon scoparius*), and the forbs Douglas dusty maiden (*Chaenactis douglasii*) and white prairie clover (*Dalea candida*). In addition to these, yellow buckwheat (*Eriogonum flavum*), hairy goldenaster (*Heterotheca villosa*), alpine bladderpod (*Lesquerella alpina*), and plains muhly (*Muhlenbergia cuspidata*) have also been noted as common associates (North Dakota Natural Heritage Program 1990).

SPECIES BIOLOGY: Estimates of Montana population numbers range from 20 to 100 plants. Highest number of plants observed was at the BLM site near Newberry knob at the north end of the Chalk Buttes. Only about 20 plants were observed at the Powderville Road BLM occurrence, however, potential habitat here is extensive but extremely difficult to traverse and a complete survey was not conducted. The Newberry Knob population extends across about 10 acres while the other occurrences cover 1 acre or less. In 1997, seed production was high in the Newberry Knob population, but most plants had aborted fruits at the Powderville Road site. Small population size may be attributed to sporadic seed production and poor competitive ability of the species.

OTHER COMMENTS: This regional endemic apparently has a rather narrow global range. Montana populations are small and may be indirectly threatened by management activities. Cattle trails dissect the population at Newberry Knob. The low growing habit of *Physaria brassicoides* protects it from grazing, and it is adapted to erosion settings, but cattle trails may facilitate invasion of exotic weeds, which are likely to be the greatest threat to populations. *Melilotus officinalis* was observed in the Newberry Knob population area, is an aggressive colonizer of barren habitats in Carter County, and has been noted as a management concern for the species elsewhere in its range (North Dakota Natural Heritage Program 1990). With the discovery of *Physaria brassicoides* on BLM land, BLM watch status designation is appropriate.

***Psoralea hypogaea* Nuttall**
LITTLE INDIAN BREADROOT
Bean Family (Fabaceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None

Bureau of Land Management: Watch

Montana Natural Heritage Program: G5 S2; The species is demonstrably secure throughout its range, but may be imperiled in Montana where it is rare.

DESCRIPTION: Little indian breadroot is a perennial herb with a deeply buried, club-shaped, edible root, up to 6 cm (2 in) long, surmounted by a subterranean connecting stem. Above ground, the stem enlarges and gives rise to a rosette of long-petioled, palmately divided into 3-7 linear-elliptic leaflets, 25-50 mm (1-2 in) long. Foliage is covered with dot-like glands and dense white appressed hairs, but upper leaf surfaces become glabrous with age. Blue, pea-like flowers are borne in condensed spikes arising among the bases of the leaf petioles at or barely above ground level. The tubular calyx, 6-9 mm long, has 4 long, narrow lobes and a fifth that is longer and broader. The upper petal is 10-13 mm long and points forward. The hairy pods are egg-shaped, ca. 5 mm long, with a beak, 5-13 mm long. Seeds have conspicuous irregular ridges on their faces.

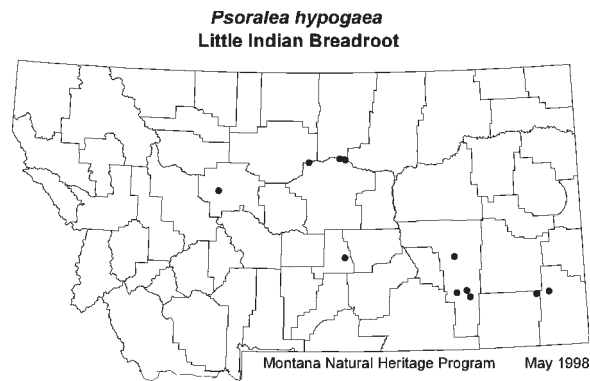
Psoralea hypogaea superficially resembles a stemless lupine such as *Lupinus lepidus*; however, lupines lack glandular dots on the leaf surfaces. It most closely resembles common indian breadroot (*Psoralea esculenta*), which differs from little indian breadroot in having elongated aboveground stems.

GEOGRAPHIC DISTRIBUTION

Global distribution: Great Plains; central to eastern Montana, eastern Wyoming, north central to western Nebraska, eastern Colorado, western Kansas, western Oklahoma, northern Texas, and northeastern New Mexico (Great Plains Flora Association 1986, and MTNHP records).

Montana distribution: Carter, Cascade, Choteau, Fergus, Golden Valley, Powder River, and Rosebud counties.

Carter County distribution: One population was found in 1997 on BLM land along the Powderville Road west of Chalk Buttes.



HABITAT: The Carter County population is in a small blowout below the crest of a sandy ridge. It is associated with prairie sandreed (*Calamovilfa longifolia*) and sand bladderpod (*Lesquerella arenosa*).

SPECIES BIOLOGY: Little indian breadroot is a long-lived perennial with a deeply buried root that enables it to survive burial or loss of surface material associated with wind erosion. This species is now known from seven counties in Montana, a relatively large number, with many new records since it was first reported to the BLM (Heidel 1994). But its population numbers are usually very low. The Carter County population had only six plants.

OTHER COMMENTS: The breadth of species' distribution and its occupancy in tiny areas of suitable habitat suggests that this species may not be warranting the S2 (state imperiled) rank. Its state rank is likely to change in the future, but this change will be made based on documentation rather than projection.

This is one of several sand-loving species in the county that are often found with other species of special concern where the habitat is extensive and/or in good condition.

Quercus macrocarpa Michaux
BUR OAK
Oak Family (Fagaceae)

CONSERVATION STATUS

U.S. Fish and Wildlife Service: None

Bureau of Land Management: Sensitive

Montana Natural Heritage Program: G5 S1; demonstrably secure globally, but may be critically imperiled in Montana where it is extremely rare.

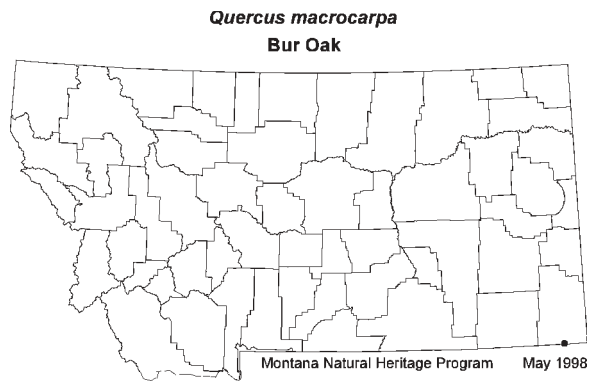
DESCRIPTION: Bur oak is a small to large tree. Its bark is deeply furrowed and twigs are stout. The alternate, oblong-elliptic leaves, to 20 cm (8 in) long, are deeply to shallowly lobed with the terminal lobe the largest. They are dark green above, but silvery below with fine, star-shaped hairs. Male flowers of 5-10 stamens are borne in long, loose, pendulous inflorescences from the leaf axils. 1-several female flowers occur in the axils of new leaves. The acorn is 2-4 cm long, ellipsoidal, and the bottom half or more of the acorn is enclosed by a roughened, fringe-margined cup. Acorns mature in one year, often persisting. This is Montana's only native oak.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Eastern temperate North America, from New Brunswick to Saskatchewan, south to Maryland, Arkansas and Texas (Great Plains Flora Association 1986). This stand is contiguous with Black Hills oak, and is upstream on the Little Missouri River from stands on escarpments and coulee systems that may reflect its relict origin.

Montana distribution: Carter County. The single stand in Montana straddles the state lines and extends into adjoining Crook County, Wyoming.

Carter County distribution: The species in Montana spans over 1,000 acres, but only a fraction of this area has an oak-dominated plant association, and there are only an estimated 12 acres of oak-dominated plant association on local BLM-administered lands (Heidel 1993). Most of the oak stand is on private or state ownership, and many of the oak trees intersperse with other vegetation types. The species is concentrated in the area within two miles north of the Wyoming border and south of Alzada. An area of oak co-dominance also occurs on a scattered BLM tract along Arkansas Creek, tributary of the Little Missouri River. All BLM tracts in the vicinity were surveyed and/or



evaluated for presence of bur oak (*Quercus macrocarpa*). Survey was not conducted outside of the Thompson Creek tract but it is possible that there are scattered trees if not oak groves elsewhere in the drainage.

HABITAT: The Montana population of bur oak (*Quercus macrocarpa*) occurs in two, relatively discrete settings. Most of the population occurs on bentonitic shale ridges trending WNW to ESE that extend south into Wyoming. They form solid stands or mixed stands on slopes, and are widely scattered in a savanna-like association on the ridgetops. The bur oak (*Quercus macrocarpa*) is codominant in various proportions with Rocky Mountain juniper (*Juniperus scopulorum*) and ponderosa pine (*Pinus ponderosa*). The undergrowth is relatively depauperate even under continuous canopy cover. Openings are often dominated by the rhizomatous sedge, sun sedge (*Carex inops*; syn. *C. heliophila*). Shrubs are confined to the more wooded stands. The grass and forb components have a high proportion of and cover by exotic species. There is a high diversity of annuals in the undergrowth including blue toadflax (*Linaria canadensis*).

A small portion of the Montana oaks grow on alluvial terraces along the Thompson Creek, tributary of the Little Missouri River, where they are the dominant tree or occasional in stands of green ash (*Fraxinus pensylvanica*). These habitats have understories dominated by introduced hay grasses, in many places a near monoculture of smooth brome (*Bromus inermis*). There are three BLM tracts with oaks present in upland woodlands and one tract with riparian oak woodland. Vegetation was sampled by plots at two sites on BLM land, one representing a *Quercus macrocarpa*/*Juniperus scopulorum* community on the toeslope of the shale ridge setting, and one representing a *Q. macrocarpa*/*Bromus inermis* community type in the alluvial terrace setting. Elsewhere, it grows on limestone escarpments and woody draws (Girard et al. 1988).

SPECIES BIOLOGY: This is a peculiar case in which a state-significant plant association is dominated by a state-significant species. The single Montana population is estimated to consist of 5,000-10,000 trees, present on over 1,000 acres; with densities ranging from 1 to 20 trees per acre (Heidel 1993). Much of the 360 acres of BLM-administered land in the area has oak trees, while only a small fraction have oak-dominated vegetation (Heidel 1993).

Bur oak can grow to be an extremely big, long-lived tree elsewhere in its range (over 300 years old, 1 m DBH, 30 m high and twice as wide). Bur oak in the Black Hills area shows some of the genetic traits of Garry's oak (*Quercus Gerri*), perhaps reflecting an overlap in their range under different climates (source). In Carter County, mature oak trees which were bored were estimated to be 60 years old (average tree of app. 0.15 m DBH in upland stand) to 110 years old (largest tree of riparian stand; Heidel 1993). It may be short-lived under the stress at the edge of its range, dependent on resprouting for persistence, or showing effects of land use. Low acorn production was reported in 1992 and no acorns were seen in the two BLM stands visited in 1997. Few seedlings were seen in the 1997 vegetative sampling plots, but reproduction by suckers growing from dying (uncommon) and healthy trees was noted. Many trees are multi-trunked. This is explained either by resprouting of trees when the tops were killed in the past by, e.g., fire, browsing, or logging; the suckering noted, or patterns of seed dispersal by fox squirrels caching acorns underground.

OTHER COMMENTS: The 'Alzada Oaks' are Montana's only stand of bur oak (*Quercus macrocarpa*), and part of the westernmost natural occurrences of the species. They have been influenced

by mining, associated road building, and grazing, but represent the only place where the species and plant association occur naturally in the state. BLM tracts represent the only portion of the stand on public lands administered by agencies with sensitive species or natural areas programs. The BLM-administered tracts within the Alzada Oaks are said to have been withdrawn from ACEC consideration (Vosen pers. commun.), and land exchanges for high quality oak stands have not been considered to date.

***Solidago ptarmicoides* (Nees) Boivin**
PRAIRIE ASTER
Sunflower Family (Asteraceae)

CONSERVATION STATUS

U. S. Fish and Wildlife Service: None

Bureau of Land Management: None

Montana Natural Heritage Program: G5 S1; demonstrably secure globally, but may be critically imperiled in Montana where it is extremely rare.

DESCRIPTION: Prairie aster is a perennial herb with stems 1-7 dm tall which grow in a cluster from a branched, somewhat woody rootcrown. The leaves are alternate, stiff, glabrous, distinctly light green, and 3-veined with parallel veins. The lower leaves are narrow, lance-shaped, 3-20 cm long and 3-10 mm wide, and have broadened petioles with margins fringed with hairs. Above, leaves are progressively reduced to mere bracts without petioles. The inflorescence is open and flat topped, with 3-60 composite flower heads. Each head is encircled by 3-4 series of greenish involucre bracts that enclose 10-25 marginal ray flowers with corollas like daisy petals, 5-9 mm long. The rays surround numerous disk flowers, which have tubular, creamy white corollas. The bases of ray and disk corollas are circled by a ring of white bristles that are thickened toward the top. Flowering in August-September.

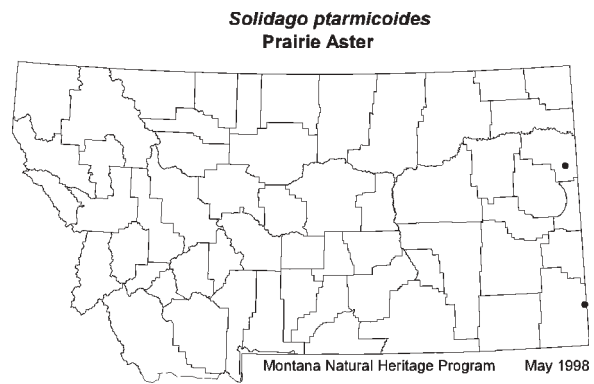
This species differs from all other *Solidago* in having white flowers, resembling an *Aster*. It can be distinguished from the latter by its flat-topped inflorescence, thickened involucral bracts that are often blunt at the tips, thickened pappus bristles, and 3-veined leaves.

GEOGRAPHICAL DISTRIBUTION

Global distribution: Great Lakes, Midwest and northern Great Plains; from Quebec and New York to eastern Montana, south to Missouri and eastern Wyoming; and locally to Georgia and Arkansas (Great Plains Flora Association 1986).

Montana distribution: Carter and Richland counties.

Carter County distribution: One population was located in 1996 by Keith Dueholm on the Custer National Forest in the Ekalaka Hills.



HABITAT: Habitat throughout its range is described as open, drying prairies, often on limestone bluffs, or sandy areas (Great Plains Flora Association 1986). In South Dakota it is reported as common in dry prairie and open woods over the state (Van Bruggen 1985) and in Wyoming it is reported from prairie hills, and open woods (Dorn 1992). It occurs on south-facing ridge slopes overlying limestone in Harding Co., SD but has not been found to date on the most similar local habitat on Chalk Butte (Heidel and Dueholm 1995). The occurrence in the Ekalaka Hills was in partial shade of ponderosa pine (*Pinus ponderosa*) on a dry ridge above an escarpment. The soil was a sandy loam with sandstone parent material, and Missouri goldenrod (*Solidago missouriensis*) was an associate.

SPECIES BIOLOGY: Prairie aster is a long-lived perennial with a deep root system. It does not have a rhizome like many other *Solidago* so it is widely-scattered rather than occurring in dense patches. Population size estimates are not available for either of the Montana occurrences.

OTHER COMMENTS: There is no evidence to indicate that it likely to occur on BLM-administered lands in the state. Therefore, no BLM status is recommended.

DISCUSSION

A biodiversity picture of Carter County emerges in piecing together the ecological and botanical results of this study. In it we identify the priority features, working toward a cohesive view of what is truly rare on BLM-administered lands and the state as a whole and the relative significance of BLM lands in the sustainability of these features across the county and state. The immediate products are recommendations for deleting and adding sensitive species, the tools for identifying them in the field, a reference for coordinating with other natural resource agencies in the state on vegetation and sensitive species, and a body of reference information for management planning.

The Carter County total of 18 Montana plant species of special concern represents the highest number of rare Great Plains found in any single county of Montana, explained by the county location as well as its diversity of plains habitat. Nine of these species are on BLM-administered lands. Two of these are regional endemics, Visher's buckwheat (*Eriogonum visherii*) and bladder twinpod (*Physaria brassicoides*), that are known from Montana only in Carter County. Three of the 18 species occur only on BLM lands among public lands in the county, including raceme milkvetch (*Astragalus racemosus*), Visher's buckwheat (*Eriogonum visherii*), and bur oak (*Quercus macrocarpa*); possibly also blue toadflax (*Linaria canadensis* var. *texana*). Immediate threats were not identified for any of the nine species, except that two populations of narrow-leaved milkweed (*Asclepias stenophylla*) are in apparent decline.

The results from this study do not mean that each occurrence of the species regarded as rare need fences around them now that they have been discovered. Instead, the information is to be taken as indication that the lands may represent something unusual. These species are all habitat specialists that tell a story about range sites and plant associations. This information can potentially be used to avert endangerment, maintain the vigor of species at geographic outposts that are integral to overall conservation, and come to better terms of appreciation for the diversity scattered across the plains.

The total number of vascular plant species known to date from Carter County (507) is a significant fraction (over 20%) of the species known in the entire state. It is only a preliminary flora because it represents floristic documentation that was a secondary part of the studies, and it represents a compilation drawing from public lands studies. Nevertheless, it presents a basis for comparison with the more completely inventoried counties in South Dakota, North Dakota and Wyoming, as well as a future reference in eastern Montana where county floras have not been prepared. At least as significant as the diversity of native species is the relative paucity of noxious weeds. Apart from the species of special concern, the native flora may not warrant single-species attention but ongoing weed control vigilance and maintenance of the natural vegetation.

It has been remarked that vegetation, more than any other biotic feature, gives character to the landscape (Knight 1996) and Carter County is distinguished by expansive tracts of intact native plains vegetation, rendering this one of the most intriguing of landscapes. We have made huge strides in documenting the vegetation. The most heartening result of this study on BLM-administered lands is that it has become evident that a number of plant associations considered potentially vulnerable (ranked G1-G3) may be more widespread than previously known and are recommended for rank changes to G4 or G5 as discussed below.

Yet the identification of priority features among the plant associations is preliminary at best. We highlight the bur oak plant associations (*Quercus macrocarpa*/*Carex inops* and *Quercus macrocarpa*/*Symphoricarpos occidentalis*) as having high state significance, with more work needed between states to determine rangewide status and to identify the best sites. The other most structurally- and compositionally distinct forest and woodland types on BLM lands in the county are the *Pinus ponderosa*/*Juniperus communis* p.a. and the *Juniperus scopulorum*/*Oryzopsis micrantha* p.a., respectively. The most uncommon woodland type in the county on BLM lands is the *Populus deltoides*/*Symphoricarpos occidentalis* p.a., and it is the most threatened rangewide due to habitat decline.

Not all of the sensitive species and uncommon plant associations in the county are best-represented on BLM lands. For example, one of the highest concentrations of sensitive species in Carter County is semi-protected in Medicine Rocks State Park, with seven sensitive species.

Few, if any, communities/plant associations on BLM-administered land in the county can be said to be irreplaceable across their range. Yet stands of common plant communities making up shrublands and grasslands, especially those that constitute the most productive of common types (*Pascopyrum smithii* (*Elymus lanceolatus*), *Pascopyrum smithii* ñ *Bouteloua gracilis* ñ *Carex filifolia* and *P. smithii* ñ *Nasella viridula*) in good to excellent condition, are in fact relatively uncommon. Our survey found examples of high quality sites for most but not all of the common vegetation types. Identification of such sites can serve as rangeland baseline references used to interpret the results of land management decisions, as well as home for a host of native wildlife and plants. Indeed, the best opportunities for identifying some of these types in the state should be found where they are most extensive on the BLM-administered lands of Carter County.

The individual communities and species of Carter County may not be globally imperiled, but they collectively contribute to high Great Plains diversity and biological integrity. We have described vegetation types rather than whole landscapes, but note that there are extensive areas of BLM-administered land where the gradient from dry-to-wet habitat is intact, and where an array of slopes, aspects, and sometimes substrates is represented. The BLM lands make up the core of the largest unbroken blocks of plains in the county, a rangeland resource of increasing importance.

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APPENDIX A.

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APPENDIX B. ELEMENT OCCURRENCE RECORDS

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Appendix C.

PRELIMINARY FLORA OF CARTER COUNTY

TREES

Scientific name ¹	Common name	Non-native	Notes ²	Code used in sampling data
<i>Acer negundo</i>	Box-elder		B	ACENEG
<i>Betula papyrifera</i>	Paper Birch		CB	BETPAP
<i>Fraxinus pennsylvanica</i>	Green Ash		B	RAPEN
<i>Juniperus scopulorum</i>	Rocky Mountain Juniper			JUNSCO
<i>Pinus ponderosa</i>	Ponderosa Pine			PINPON
<i>Populus deltoides</i>	Great Plains Cottonwood		B	POPDEL
<i>Populus tremuloides</i>	Quaking Aspen		CB, EH, LP	POPTRE
<i>Quercus macrocarpa</i>	Bur Oak		B	QUEMAC
<i>Salix amygdaloides</i>	Peach-leaf Willow			SALAMY
<i>Ulmus americana</i>	American Elm		B, CB, O	ULMAME

SHRUBS

<i>Amelanchier alnifolia</i>	Western Serviceberry		B	AMEALN
<i>Amorpha canescens</i>	Lead Plant		B	AMOCAN
<i>Arctostaphylos uva-ursi</i>	Kinnikinnick			ARCUVA
<i>Artemisia cana</i>	Silver Sagebrush			ARTCAN
<i>Artemisia frigida</i>	Fringed Sagewort			ARTFRI
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>	Wyoming Big Sagebrush			ARTTSW
<i>Atriplex confertifolia</i>	Shadscale		B	ATRCAN
<i>Atriplex gardneri</i>	Gardner's Saltsage		B	ATRGAR
<i>Betula occidentalis</i>	Water Birch			BETOCC
<i>Chrysothamnus nauseosus</i> ssp. <i>nauseosus</i>	Rubber Rabbitbrush			CHRNEN
<i>Chrysothamnus viscidiflorus</i>	Green Rabbitbrush			CHRVIS
<i>Clematis ligusticifolia</i>	Western Virgins-bower			CLELIG
<i>Cornus stolonifera</i>	Red-osier Dogwood			CORSTO
<i>Crataegus chrysocarpa</i>	Yellow-fruit Hawthorn			CRACHR
<i>Gutierrezia sarothrae</i>	Broom Snakeweed			GUTSAR
<i>Juniperus communis</i>	Common Juniper			JUNCOM
<i>Juniperus horizontalis</i>	Creeping Juniper			JUNHOR
<i>Krascheninnikovia lanata</i>	Winterfat			KRALAN
<i>Linnaea borealis</i>	Twinflower			LINBOR
<i>Mahonia repens</i>	Creeping Oregongrape			MAHREP
<i>Prunus americana</i>	Wild Plum			PRUAME
<i>Prunus virginiana</i>	Common Chokecherry		B	PRUVIR
<i>Rhus trilobata</i>	Skunk-bush Sumac			RHUTRI
<i>Ribes americanum</i>	Black Currant			RIBAME
<i>Ribes aureum</i>	Golden Currant			RIBAU
<i>Ribes cereum</i>	Squaw Currant			RIBCER
<i>Ribes setosum</i>	Missouri Gooseberry			RIBSET
<i>Rosa acicularis</i>	Prickly Rose			ROSACI
<i>Rosa arkansana</i>	Arkansas Rose			ROSARK
<i>Rosa woodsii</i>	Woods Rose			ROSWOO

¹ Species are grouped by lifeform, and alphabetically within these groups by scientific name.

² All species on this list were noted on BLM lands except for those which are on USFS lands (Ekalaka Hills=EH, Long Pines =LP, Chalk Buttes=CB), on Medicine Rocks State Park (MR), or noted elsewhere in passing (O). This list also includes the county flora information represented in earlier statewide floras (Booth 1950, Booth and Wright 1966). All reports in the latter are based on voucher specimens. All collections made in the course of the 1997 survey are bold-faced.

<i>Rubus idaeus</i>	Red Raspberry			RUBIDA
<i>Salix bebbiana</i>	Bebb Willow			SALBEB
<i>Salix exigua</i>	Sandbar Willow		B	SALEXI
<i>Salix scouleriana</i>	Scouler Willow			SALSCO
<i>Sarcobatus vermiculatus</i>	Black Greasewood		B	SARVER
<i>Shepherdia argentea</i>	Thorny Buffaloberry			SHEARG
<i>Shepherdia canadensis</i>	Canada Buffaloberry		CB	SHECAN
<i>Symphoricarpos albus</i>	Common Snowberry			SYMALB
<i>Symphoricarpos occidentalis</i>	Western Snowberry			SYMOCC
<i>Symphoricarpos oreophilus</i>	Mountain Snowberry		B	SYMORE
<i>Toxicodendron rydbergii</i>	Poison Ivy			TOXRYD
<i>Yucca glauca</i>	Yucca			YUCGLA

GRASSES AND GRASS-LIKE PLANTS

<i>Agropyron cristatum</i>	Crested Wheatgrass	X		AGRCRI
<i>Agrostis scabra</i>	Tickle-grass	X	97	AGRSCA
<i>Alopecurus geniculatus</i>	Water Foxtail			ALOGEN
<i>Andropogon gerardii</i>	Big Bluestem			ANDGER
<i>Andropogon hallii</i>	Sand Bluestem		MR, O	ANDHAL
<i>Aristida purpurea</i>	Red Threeawn			ARIPUR
<i>Beckmannia syzigachne</i>	American Sloughgrass			BECSYZ
<i>Bouteloua curtipendula</i>	Sideoat Grama			BOUCUR
<i>Bouteloua gracilis</i>	Blue Grama			BOUGRA
<i>Bromus anomalus</i>	Nodding Brome			BROANA
<i>Bromus carinatus</i>	Mountain Brome			BROCAR
<i>Bromus ciliatus</i>	Fringed Brome			BROCIL
<i>Bromus commutatus</i>	Hairy Brome			BROCOM
<i>Bromus inermis</i>	Smooth Brome	X		BROINE
<i>Bromus japonicus</i>	Japanese Brome	X		BROJAP
<i>Bromus tectorum</i>	Cheatgrass	X		BROTEC
<i>Buchloe dactyloides</i>	Buffalo Grass			BUCDAC
<i>Calamovilfa longifolia</i>	Prairie Sandreed			CALLON
<i>Carex backii</i>	Back's Sedge		97	CARBAC
<i>Carex brevior</i>	Short-beaked Sedge			CARBRE
<i>Carex douglasii</i>	Douglas's Sedge			CARDOU
<i>Carex filifolia</i>	Thread-leaved Sedge			CARFIL
<i>Carex foenea</i>	Silvertop Sedge			CARFOE
<i>Carex inops</i>	Long-stolon Sedge			CARINO
<i>Carex lanuginosa</i>	Woolly Sedge			CARLAN
<i>Carex nebrascensis</i>	Nebraska Sedge			CARNEB
<i>Carex parryana ssp parryana</i>	Parry's Sedge			CARPAR
<i>Carex sprengelii</i>	Sprengel's Sedge			CRSPR
<i>Carex stenophylla</i>	Narrow-leaved Sedge			CARSTE
<i>Carex stipata</i>	Sawbeak Sedge			CARSTI
<i>Carex tenera</i>	Slender Sedge		97	CARTEN
<i>Carex torreyi</i>	Torrey's Sedge		LP	CARTOR
<i>Carex vulpinoidea</i>	Fox Sedge			CARVUL
<i>Carex xerantica</i>	Dryland Sedge		97	CARXER
<i>Catabrosa aquatica</i>	Brookgrass			CATAQU
<i>Cyperus schweinitzii</i>	Schweinitz's Flatsedge		97	CYPSCH
<i>Dactylis glomerata</i>	Orchard-grass	X		DACGLO
<i>Danthonia intermedia</i>	Timber Oatgrass			CANINT
<i>Danthonia unispicata</i>	Onespike Oatgrass			DANUNI
<i>Dichanthelium wilcoxianum</i>	Wilcox Witchgrass		LP	DICWIL

<i>Distichlis stricta</i>	Alkali Saltgrass			DISSTR
<i>Eleocharis acicularis</i>	Needle Spike-rush		97	ELEACI
<i>Eleocharis palustris</i>	Common Spikesedge			ELEPAL
<i>Eleocharis xyridiformis</i>	A spikesedge		97	ELEXYR
<i>Elymus canadensis</i>	Canada Wildrye			ELYCAN
<i>Elymus elymoides</i>	Bottlebrush Squirreltail			ELYELY
<i>Elymus hispidus</i>	Intermediate Wheatgrass	X		ELYLHIS
<i>Elymus lanceolatus</i> (<i>Agropyron dasystachyum</i>)	Thick-spike Wheatgrass		97	ELYLAN
<i>Elymus trachycaulus</i>	Bearded Wheatgrass			ELYTRA
<i>Glyceria striata</i>	Fowl Mannagrass			GLYSTR
<i>Hordeum brachyantherum</i>	Meadow Barley			HORBRA
<i>Hordeum jubatum</i>	Foxtail Barley			HORJUB
<i>Hordeum pusillum</i>	Little Barley			HORPUS
<i>Juncus balticus</i>	Baltic Rush			JUNBAL
<i>Juncus bufonius</i>	Toad Rush	X		JUNBUF
<i>Juncus interior</i>	Inland Rush		97	JUNINT
<i>Juncus tenuis</i>	Slender Rush			JUNTEN
<i>Koeleria macrantha</i>	Prairie Junegrass			KOEMAC
<i>Muhlenbergia cuspidata</i>	Plains Muhly			MUHCUS
<i>Nassella viridula</i> (<i>Stipa viridula</i>)	Green Needlegrass			NASVIR
<i>Oryzopsis hymenoides</i>	Indian Ricegrass			ORYHYM
<i>Oryzopsis micrantha</i>	Little-seed Ricegrass		97	ORYMIC
<i>Pascopyrum smithii</i> (<i>Elymus smithii</i>)	Western Wheatgrass		97	PASSMI
<i>Phleum pratense</i>	Timothy	X		PHLPRA
<i>Poa compressa</i>	Canada Bluegrass	X	97	POACOM
<i>Poa juncifolia</i>	Alkali Bluegrass		97	POAJUN
<i>Poa palustris</i>	Fowl Bluegrass	X		POAPAL
<i>Poa secunda</i>	Sandberg's Bluegrass		97	POASEC
<i>Pseudoroegneria spicata</i> (<i>Agropyron spicatum</i>)	Bluebunch Wheatgrass			PSESPI
<i>Puccinellia nuttalliana</i>	Nuttall's Alkaligrass			PUCNUT
<i>Schedonnardus paniculatus</i>	Tumblegrass			SCHPAN
<i>Schizachne purpurascens</i>	False Melic			SCHPUR
<i>Schizachyrium scoparium</i> (<i>Andropogon scoparius</i>)	Little Bluestem			SCHSCO
<i>Scirpus acutus</i>	Hardstem Bulrush			SCIACU
<i>Scirpus maritimus</i>	Alkali Bulrush		97	SCIMAR
<i>Scirpus microcarpus</i>	Small-flowered Bulrush			SCIMIC
<i>Scirpus pallidus</i>	Pale Bulrush			SCIPAL
<i>Scirpus pungens</i>	Sharp Bulrush			SCIPUN
<i>Scirpus validus</i>	Softstem Bulrush			SCIVAL
<i>Spartina gracilis</i>	Alkali Cordgrass			SPAGRA
<i>Spartina pectinata</i>	Prairie Cordgrass			SPAPEC
<i>Sphenopholis obtusata</i> var <i>obtusata</i>	Prairie Wedgegrass			SPHOBT
<i>Sporobolus airoides</i>	Alkali Sacaton			SPOAIR
<i>Sporobolus asper</i>	Rough Dropseed		97	SPOASP
<i>Sporobolus cryptandrus</i>	Sand Dropseed			SPOCRY
<i>Stipa comata</i>	Needle-and-thread			STICOM
<i>Stipa nelsonii</i>	Nelson's Needlegrass			STINEL
<i>Stipa spartea</i>	Porcupine-grass			STISPA
<i>Vulpia octoflora</i>	Six-weeks Fescue	X		VULOCT

FORBS

<i>Achillea millefolium</i>	Common Yarrow		B	ACHMIL
<i>Agastache foeniculum</i>	Lavender Giant-hyssop		LP	AGAFOE
<i>Agoseris glauca</i>	Pale Agoseris		B	AGOGLA
<i>Agrimonia striata</i>	Striate Agrimony			AGRSTR
<i>Alisma gramineum</i>	Narrowleaf Waterplantain			ALIGRA
<i>Alisma triviale</i>	American Waterplantain			ALITRI
<i>Allium geyeri</i>	Geyer's Onion			ALLGEY
<i>Allium textile</i>	Textile Onion			ALLTEX
<i>Alyssum desertum</i>	Desert Alyssum	X		ALYDES
<i>Amaranthus albus</i>	Tumbleweed	X	B	AMAALB
<i>Amaranthus retroflexus</i>	Rough Pigweed	X	B	AMARET
<i>Ambrosia artemisiifolia</i>	Annual Ragweed			AMBART
<i>Ambrosia psilostachya</i>	Western Ragweed			AMBPSI
<i>Ambrosia trifida</i>	Giant Ragweed	X	B	AMBTRI
<i>Androsace occidentalis</i>	Western Fairy-candelabra			ANDOCC
<i>Anemone cylindrica</i>	Candle Anemone			ANECYL
<i>Anemone multifida</i>	Cliff Anemone			ANEMUL
<i>Anemone patens</i>	Pasqueflower		B	ANEPAT
<i>Antennaria dimorpha</i>	Low Pussy-toes			ANTDIM
<i>Antennaria microphylla</i>	Rosy Pussy-toes			ANTMIC
<i>Antennaria neglecta</i>	Field Pussy-toes			ANTNEG
<i>Antennaria parvifolia</i>	Nuttall's Pussy-toes		B	ANTPAR
<i>Apocynum androsaemifolium</i>	Spreading Dogbane			APOAND
<i>Arabis glabra</i>	Towermustard		B	ARAGLA
<i>Arabis hirsuta</i>	Hairy Rockcress			ARAHIR
<i>Arabis holboellii</i>	Holboell's Rockcress			ARAHOL
<i>Arctium minus</i>	Common Burdock	X		ARCMIN
<i>Arenaria lateriflora</i>	Bluntleaf Sandwort			ARALAT
<i>Arnica cordifolia</i> var <i>pumila</i>	Heart-leaf Arnica			ARNCOR
<i>Arnica fulgens</i>	Orange Arnica		B	ARNFUL
<i>Arnica sororia</i>	Twin Arnica			ARNSOR
<i>Artemisia absinthium</i>	Common Wormwood	X		ARTABS
<i>Artemisia biennis</i>	Biennial Wormwood	X		ARTBIE
<i>Artemisia campestris</i>	Pacific Sagewort			ARTCAM
<i>Artemisia dracunculus</i>	Tarragon	X		ARTDRA
<i>Artemisia longifolia</i>	Long-leaved Sagewort			ARTLON
<i>Artemisia ludoviciana</i>	Prairie Sagewort			ARTLUD
<i>Asclepias ovalifolia</i>	Ovalleaf Milkweed		LP	ASCOVA
<i>Asclepias pumila</i>	Plains Milkweed			ASCPUM
<i>Asclepias speciosa</i>	Showy Milkweed		B	ASCSPE
<i>Asclepias stenophylla</i>	Narrow-leaved Milkweed			ASCSTE
<i>Asclepias viridiflora</i>	Green Milkweed			ASCVIR
<i>Aster conspicuus</i>	Showy Aster			ASTCON
<i>Aster ericoides</i> var <i>pansus</i>	Manyflowered Aster			ASTERI
<i>Aster falcatus</i>	White-prairie Aster			ASTFAL
<i>Aster laevis</i>	Smooth Aster			ASTLAE
<i>Astragalus canadensis</i>	Canada Milk-vetch			ASTCAN
<i>Astragalus adsurgens</i>	Standing Milk-vetch			ASTADS
<i>Astragalus agrestis</i>	Field Milk-vetch			ASTAGR
<i>Astragalus barrii</i>	Barr's Milk-vetch			ASTBAR
<i>Astragalus bisulcatus</i>	Two-Groove Milk-vetch		B	ASTBIS
<i>Astragalus ceramicus</i> var. <i>apus</i>	Painted Milk-vetch		97	ASTCER
<i>Astragalus crassicaupus</i>	Ground Plum		B, 97	ASTCRA

<i>Astragalus drummondii</i>	Drummond's Milk-vetch		B	ASTDRU
<i>Astragalus flexuosus</i>	Wiry Milk-vetch			ASTFLE
<i>Astragalus gilviflorus</i>	Plains Orophaca		B	ASTGIL
<i>Astragalus kentrophyta</i>	Thistle Milk-vetch			ASTKEN
<i>Astragalus lotiflorus</i>	Lotus Milk-vetch			ASTLOT
<i>Astragalus missouriensis</i>	Missouri Milk-vetch		B	ASTMIS
<i>Astragalus pectinatus</i>	Tine-leaved Milk-vetch		B	ASTPEC
<i>Astragalus purshii</i>	Pursh's Milk-vetch		B	ASTPUR
<i>Astragalus racemosus</i>	Creamy Poison Vetch		97	ASTRAC
<i>Astragalus robbinsii</i>	Robbins' Milk-vetch		B	ASTROB
<i>Astragalus spatulatus</i>	Draba Milk-vetch		B	ASTSPA
<i>Astragalus tenellus</i>	Pulse Milk-vetch			ASTTEN
<i>Astragalus vexilliflexus</i>	Bent-flowered Milk-vetch			ASTVEX
<i>Atriplex argentea</i>	Silverscale		B	ATRART
<i>Atriplex suckleyi</i>	Rillscale			ATRSUC
<i>Besseyia wyomingensis</i>	Wyoming Kittentail		B, 97	BESWYO
<i>Bidens cernua</i>	Nodding Beggar-ticks			BIDCER
<i>Brickellia eupatorioides</i>	False-boneset			BRIEUP
<i>Callitriche hermaphroditica</i>	Autumnal Water-starwort		B	CALHER
<i>Callitriche palustris</i>	Spring Water-starwort		B	CALPAL
<i>Calochortus nuttallii</i>	Sego-lilly			CALNUT
<i>Calylophus serrulatus</i>	Plains Yellow Primrose			CALSER
<i>Calystegia sepium</i>	Hedge Bindweed	X	B, 0	CALSEP
<i>Camelina microcarpa</i>	Littlepod Falseflax	X	B	CAMMIC
<i>Camelina sativa</i>	Gold-of-pleasure	X		SAMSAT
<i>Campanula rotundifolia</i>	Harebell		B	CAMROT
<i>Capsella bursa-pastoris</i>	Shepherd's-purse	X		CAPBUR
<i>Castilleja sessiliflora</i>	Downy Painted-cup		B, 97	CASSES
<i>Cerastium arvense</i>	Field Chickweed	X	B	CERARV
<i>Ceratophyllum demersum</i>	Hornwort			CERDEM
<i>Chaenactis douglasii</i>	Hoary Chaenactis			CHADOU
<i>Chamaerhodos erecta</i>	Chamaerhodos			CHAEERE
<i>Chamaesyce geyseri</i>	Geyer's Spurge			CHAGEY
<i>Chenopodium album</i>	Lambsquarter	X		CHEALB
<i>Chenopodium subglabrum</i>	Slimleaf Goosefoot		MR	CHESUB
<i>Chorispora tenella</i>	Blue mustard	X		CHITEN
<i>Cicuta douglasii</i>	Douglas Water-hemlock			CICDOU
<i>Cirsium arvense</i>	Canada thistle	X		CIRARV
<i>Cirsium canescens</i>	Platte Thistle			CIRCAN
<i>Cirsium flodmanii</i>	Flodman's Thistle			CIRFLO
<i>Cirsium undulatum</i>	Wavy-leaved Thistle			CIRUND
<i>Cleome serrulata</i>	Rocky Mountain Bee Plant		B	CLESER
<i>Collinsia parviflora</i>	Small-flowered Blue-eyed Mary			COLPAR
<i>Collomia linearis</i>	Narrow-leaf Collomia		B	COLLIN
<i>Comandra umbellata</i>	Bastard Toad-flax		B	COMUMB
<i>Conringia orientalis</i>	Mustard Hare's Ear	X		CONORI
<i>Conyza canadensis</i>	Horseweed	X		CONCAN
<i>Corydalis aurea</i>	Golden Corydalis			CORAUR
<i>Coryphantha missouriensis</i>	Missouri Coryphantha			CORMIS
<i>Coryphantha vivipara</i>	Pincushion Cactus			CORVIV
<i>Crepis acuminata</i>	Tapertip Hawksbeard			CREACU
<i>Crepis runcinata</i>	Meadow Hawksbeard			CRERUN
<i>Cryptantha celosioides</i>	Northern Cryptantha			CRYCEL

<i>Cymopterus acaulis</i>	Plains Cymopterus		B	CYMCA
<i>Cymopterus terebinthinus</i>	Turpentine Cymopterus		B	CYMTER
<i>Cynoglossum officinale</i>	Common Hound's-tongue	X		CYNOFF
<i>Dalea candida</i>	White Prairie-clover		B	DALCAN
<i>Dalea purpurea</i>	Purple Prairie-clover		B	CALPU
<i>Dalea villosa</i>	Silky Prairie-clover		MR, O	CALVIL
<i>Delphinium bicolor</i>	Little Larkspur		B	DELBIC
<i>Descurainia pinnata</i>	Pinnate Tansymustard	X		DESPIN
<i>Descurainia sophia</i>	Flixweed Tansymustard	X		DESSOP
<i>Disporum trachycarpum</i>	Wartberry Fairy-bell			DISTRA
<i>Echinacea angustifolia</i>	Pale Purple Coneflower			ECHANG
<i>Ellisia nyctelea</i>	Nyctelea			ELLNYC
<i>Epilobium angustifolium</i>	Fireweed			EPIAND
<i>Erigeron glabellus</i>	Smooth Daisy			ERIGLA
<i>Erigeron ochroleucus</i>	Buff Fleabane			ERIOCH
<i>Erigeron philadelphicus</i>	Philadelphia Fleabane			ERIPHI
<i>Erigeron pumilus</i>	Shaggy Fleabane			ERIPUM
<i>Erigeron strigosus</i>	Branching Daisy			ERISTR
<i>Erigeron subtrinervis</i>	Three-veined Fleabane			ERISUB
<i>Eriogonum annuum</i>	Annual Buckwheat		B	ERIANN
<i>Eriogonum cernuum</i>	Nodding Wild Buckwheat			ERICER
<i>Eriogonum flavum</i>	Yellow Buckwheat			ERIFLA
<i>Eriogonum pauciflorum</i>	Few-flowered Wild Buckwheat		B	ERIPAU
<i>Eriogonum visherii</i>	Visher's Eriogonum		97	ERIVIS
<i>Erysimum asperum</i>	Plains Wallflower		B	ERYASP
<i>Erysimum repandum</i>	Spreading wallflower			ERYREP
<i>Euphorbia cyparissias</i>	Cypress Spurge			EUPCYP
<i>Euphorbia esula</i>	Leafy spurge	X		EUPESU
<i>Euphorbia glyptosperma</i>	Corrugate-seeded Spurge		B	EUPGLY
<i>Euphorbia robusta</i>	Rocky Mountain Spurge		B	EUPROB
<i>Euphorbia spathulata</i>	Spatulate-leaved Spurge		B	EUPSPA
<i>Filago arvensis</i>	Field Filago	X		FILARV
<i>Fragaria vesca</i>	Woods Strawberry			FRAVES
<i>Fragaria virginiana</i>	Virginia Strawberry		B	FRAVIR
<i>Fritillaria atropurpurea</i>	Checker Lily			FRIATR
<i>Gaillardia aristata</i>	Blanketflower		CB	GAIARI
<i>Galium aparine</i>	Goose-grass			GALAPA
<i>Galium bifolium</i>	Thinleaf Bedstraw		B	GALBIF
<i>Galium boreale</i>	Northern Bedstraw		B	GALBOR
<i>Galium trifidum</i>	Small Bedstraw			GALTRI
<i>Gaura coccinea</i>	Scarlet Gaura		B	GAUCOC
<i>Gayophytum diffusum</i>	Spreading Groundsmoke			GAYDI
<i>Gentianella amarella</i>	Northern Gentian			GENAMA
<i>Geranium bicknellii</i>	Bicknell's Geranium			GERBIC
<i>Geum aleppicum</i>	Yellow Avens			GEUALE
<i>Geum canadense</i>	White Avens			GEUCAN
<i>Geum macrophyllum</i>	Large-leaved Avens			GEUMAC
<i>Geum triflorum</i>	Prairie Smoke			GEUTRI
<i>Glycyrrhiza lepidota</i>	American Licorice		B	GLYLEP
<i>Gnaphalium palustre</i>	Lowl Cudweed			GNAPAL
<i>Grindelia squarrosa</i>	Curlycup Gumweed			GRISQU
<i>Habenaria hyperborea</i>	Northern Green Bog-orchid		LP	HABHYP

<i>Habenaria viridis</i>	Frog Orchis			HABVIR
<i>Hackelia deflexa</i>	Nodding Stickseed	X		HACDEF
<i>Haplopappus multicaulis</i>	Many-stemmed Goldenweed			HAPMUL
<i>Haplopappus spinulosus</i>	Shiny Goldenweed		CB	HAPSPI
<i>Hedeoma drummondii</i>	Drummond False Pennyroyal		B	HEDDRU
<i>Hedeoma hispida</i>	Rough Pennyroyal			HEDHIS
<i>Helianthus annuus</i>	Common Sunflower			HELANN
<i>Helianthus maximiliani</i>	Maximilan's Sunflower			HELMAX
<i>Helianthus petiolaris</i>	Prairie Sunflower			HELPET
<i>Helianthus rigidus</i>	Showy Sunflower			HELRIG
<i>Heracleum lanatum</i>	Cow-parsnip		B	HERLAN
<i>Hesperis matronalis</i>	Dame's Rocket	X	O	HESMAT
<i>Heterotheca villosa</i>	Hairy Golden-aster			HETVIL
<i>Heuchera richardsonii</i>	Richardson's Alumroot		97	HEURIC
<i>Hippuris vulgaris</i>	Common Mare's-tail			HIPVUL
<i>Humulus americanus</i>	American Hop			HUMAME
<i>Hymenopappus filifolius</i>	Columbia Cut-leaf			HYM[IL
<i>Hymenoxys acaulis</i>	Stemless Hymenoxys			HYMACA
<i>Ipomopsis congesta</i>	Ballhead Gilia		B, 97	IPOCON
<i>Iva axillaris</i>	Poverty-weed			IVAAXI
<i>Kochia scoparia</i>	Summer Cypress	X		KOCSCO
<i>Lactuca pulchella</i>	Blue Lettuce			LACPUL
<i>Lappula redowskii</i>	Western Stickseed			LAPRED
<i>Lathyrus ochroleucus</i>	Cream-flowered Peavine		B	LATOCH
<i>Lemna minor</i>	Duckweed			LEMMIN
<i>Lepidium densiflorum</i>	Prairie Pepperweed	X		LEPDEN
<i>Lepidium perfoliatum</i>	Clasping pepperweed	X		LEPPER
<i>Lepidium virginicum</i>	Tall Pepperweed	X		LEPVIR
<i>Lesquerella alpina</i>	Alpine Bladderpod		97	LESALP
<i>Lesquerella arenosa</i>	Sand Bladderpod			LESARE
<i>Lesquerella ludoviciana</i>	Silvery Bladderpod		B	LESLUD
<i>Leucocrinum montanum</i>	Mountain Lily			LEUMON
<i>Liatris punctata</i>	Dotted Blazing-star			LIAPUN
<i>Limosella aquatica</i>	Mudwort		B	LIMAQU
<i>Linaria canadensis var texana</i>	Blue Toadflax			LINCAN
<i>Linum lewisii</i>	Wild Blue Flax		B	LINLEW
<i>Linum rigidum</i>	Yellow Flax			LINRIG
<i>Lithophragma parviflorum</i>	Smallflower Woodlandstar			LITPAR
<i>Lithospermum incisum</i>	Yellow Gromwell			LITINC
<i>Lomatium foeniculaceum</i>	Fennel-leaved Desert-parsley		B	LOMFOE
<i>Lomatium triternatum</i>	Nine-leaf Lomatium			LOMTRI
<i>Lotus purshianus</i>	Spanish-clover	X		LOTPUR
<i>Lupinus argenteus</i>	Silvery Lupine		B	LUPARG
<i>Lupinus pusillus</i>	Rusty Lupine		B, 0	LUPPUS
<i>Lycopus americanus</i>	Cut-leaved Water Horehound			LYCAME
<i>Lygodesmia juncea</i>	Rush-like Skeletonweed			LYGJUN
<i>Lysimachia ciliata</i>	Fringed Loosestrife			LYSCIL
<i>Machaeranthera canescens</i>	Hoary Aster			MACCAN
<i>Machaeranthera grindelioides</i>	Nuttall's Goldenweed			MACGRI
<i>Machaeranthera pinnatifida</i>	Spiny Goldenweed			MACPIN

<i>Maianthemum canadense</i> var <i>interius</i>	Wild Lily-of-the-valley		B	MAICAN
<i>Maianthemum stellatum</i>	Starry Solomon-plume			MAISTE
<i>Malcolmia africana</i>	Malcolmia	X	O	MALAFR
<i>Matricaria matricarioides</i>	Pineapple Weed	X		MATMAT
<i>Medicago lupulina</i>	False Medic	X		MEDLUP
<i>Medicago sativa</i>	Alfalfa	X		MEDSAT
<i>Melilotus alba</i>	White Sweetclover	X		MELALB
<i>Melilotus officinalis</i>	Yellow Sweetclover	X		MELOFF
<i>Mentha arvensis</i>	Field Mint			MENART
<i>Mentzelia decapetala</i>	Evening Star			MENDEC
<i>Mentzelia dispersa</i>	Bushy Mentzelia			MENDIS
<i>Mertensia lanceolata</i>	Lanceleaf Bluebells			MERLAN
<i>Mertensia oblongifolia</i>	Oblongleaf Bluebells			MEROBL
<i>Microseris cuspidata</i>	Toothed Microseris			MICCUS
<i>Microseris nutans</i>	Nodding Microseris			MICNUT
<i>Microsteris gracilis</i>	Pink Microsteris		B	MICGRA
<i>Mirabilis hirsuta</i>	Hairy Four-o'clock		MR	MIRHIR
<i>Monarda fistulosa</i>	Horsemint		B	MONFIS
<i>Monolepis nuttalliana</i>	Poverty Weed		B	MONNUT
<i>Musineon divaricatum</i>	Leafy Musineon		B	MUSDIV
<i>Nepeta cataria</i>	Catnip	X		NEPCAT
<i>Oenothera albicaulis</i>	Prairie Evening-primrose		B	OENALB
<i>Oenothera cespitosa</i>	Desert Evening-primrose		B	OENCES
<i>Oenothera nuttallii</i>	White Evening-primrose		97	OENNUT
<i>Oenothera villosa</i>	Common Evening-primrose			OENVIL
<i>Onosmodium molle</i>	False Gromwell			ONOMOL
<i>Opuntia fragilis</i>	Brittle Prickly-pear			OPUFRA
<i>Opuntia polyacantha</i>	Plains Prickly-pear			OPUPOL
<i>Orobanche fasciculata</i>	Clustered Broomrape			OROFAS
<i>Orobanche ludoviciana</i>	Suksdorf's Broomrape		97	OROLUD
<i>Orobanche uniflora</i>	Naked Broomrape			OROUNI
<i>Orthocarpus luteus</i>	Yellow Owl-clover			ORTLUT
<i>Osmorhiza depauperata</i>	Blunt-fruit Sweet-cicely		B	OSMDEP
<i>Osmorhiza longistylis</i>	Anise Root			OSMLON
<i>Oxalis stricta</i>	Upright Yellow Wood-sorrel			OXASTR
<i>Oxytropis besseyi</i>	Bessey's Crazyweed			OXYBES
<i>Oxytropis campestris</i>	Slender Crazyweed		O	OXYCAM
<i>Oxytropis lambertii</i>	Purple Locoweed		B	OXYLAM
<i>Oxytropis sericea</i>	Silky Crazyweed; White Locoweed		B	OSYSER
<i>Parietaria pensylvanica</i>	Pennsylvania Pellitory			PARPEN
<i>Paronychia sessiliflora</i>	Stemless Whitlow-wort			PARSES
<i>Penstemon albidus</i>	White-flowered Penstemon		B	PENALB
<i>Penstemon angustifolius</i> var <i>angustifolius</i>	Narrow Beardtongue		97	PENANG
<i>Penstemon eriantherus</i>	Fuzzytongue Penstemon		B	PENERI
<i>Penstemon glaber</i>	Hairy-anther Penstemon		97	PENGLA
<i>Penstemon gracilis</i>	Slender Penstemon			PENGRA
<i>Penstemon nitidus</i>	Shining Penstemon			PENNIT
<i>Perideridia gairdneri</i>	Gairdner's Yampah			PERGAI
<i>Phacelia hastata</i>	Silverleaf Phacelia			PHAHAS
<i>Phacelia linearis</i>	Threadleaf Phacelia			PHALIN
<i>Phlox alyssifolia</i>	Alyssum-leaved Phlox		B	PHLALY
<i>Phlox andicola</i>	Moss Phlox		97	PHLAND

<i>Phlox hoodii</i>	Hood's Phlox		B	PHLHOO
<i>Phlox longifolia</i>	Long-leaved Phlox		CB	PHLLON
<i>Physalis heterophylla</i>	Clammy Ground-cherry			PHYHET
<i>Physaria brassicoides</i>	Double Bladderpod		97	PHYBRA
<i>Picradeniopsis oppositifolia</i>	Plains Bahia			PICOPP
<i>Plagiobothrys scouleri</i>	Scouler's Popcorn-flower			PLASCO
<i>Plantago elongata</i>	Slender Plantain		B	PLAELO
<i>Plantago major</i>	Common Plantain			PLAMAJ
<i>Plantago patagonica</i>	Indian-wheat	X	B	PLAPAT
<i>Polanisia trachysperma</i>	Clammy-weed			POLDOD
<i>Polygala alba</i>	White Milkwort			POLALB
<i>Polygala verticillata</i>	Whorted Milkwort			POLVER
<i>Polygonum amphibium</i>	Water Smartweed		B	POLAMP
<i>Polygonum aviculare</i>	Prostrate Knotweed		B	POLAVI
<i>Polygonum convolvulus</i>	Ivy Bindweed			POLCON
<i>Polygonum douglasii</i>	Douglas' Knotweed			POLDOU
<i>Polygonum lapathifolium</i>	Willow Weed		B	POLLAP
<i>Polygonum ramosissimum</i>	Bushy Knotweed		97	POLRAM
<i>Potentilla arguta</i>	Tall Cinquefoil			POTARG
<i>Potentilla concinna</i>	Early Cinquefoil			POTCON
<i>Potentilla gracilis</i>	Slender Cinquefoil			POTGRA
<i>Prunella vulgaris</i>	Self-heal	X		PRUVUL
<i>Psoralea argophylla</i>	Silver-leaved Scurf-pea		B	PSOARG
<i>Psoralea esculenta</i>	Indian Bread-root		B	PSOESC
<i>Psoralea hypogaea</i>	Little Breadroot Scurf-pea			PSOHYP
<i>Psoralea lanceolata</i>	Lemon Scurf-pea			PSOLAN
<i>Pterospora andromedea</i>	Woodland Pinedrops			PREAND
<i>Pyrola chlorantha</i>	Green wintergreen			PYRCHL
<i>Pyrola spp.</i>	Wintergreen			PYRSPP
<i>Ranunculus abortivus</i>	Small Flowered Buttercup			RANABO
<i>Ranunculus aquatilis</i>	White Water-buttercup			RANAQU
<i>Ranunculus cymbalaria</i>	Shore Buttercup		B, O	RANCYM
<i>Ranunculus glaberrimus</i>	Sagebrush Buttercup		B	RANGLA
<i>Ranunculus longirostris</i>	White Water-crowfoot			RANLON
<i>Ranunculus macounii</i>	Macoun's Buttercup		B	RANMAC
<i>Ranunculus sceleratus</i>	Blister Buttercup			RANSCE
<i>Ratibida columnifera</i>	Prairie Coneflower			RATCOL
<i>Rorippa sinuata</i>	Spreading Yellowcress		B	RORSIN
<i>Rorippa truncata</i>	Straight-fruit Yellowcress			RORTRU
<i>Rumex crispus</i>	Curly Dock	X	B	RUMCRI
<i>Rumex maritimus</i>	Golden Dock	X	B	RUMMAR
<i>Rumex salicifolius</i>	Willow Dock		B	RUMSAL
<i>Rumex venosus</i>	Wild Begonia			RUMVEN
<i>Sagittaria cuneata</i>	Arumleaf Arrowhead			SAGCUN
<i>Salsola collina</i>	Russian Thistle	X		SALCOL
<i>Salsola kali</i>	Russian Thistle	X	B	SALKAL
<i>Sanicula marilandica</i>	Black Snake-root			SANMAR
<i>Scrophularia lanceolata</i>	Lance-leaf Figwort			SCRLAN
<i>Sedum lanceolatum</i>	Lance-leaved Stonecrop			SEDLAN
<i>Senecio canus</i>	Woolly Groundsel			SENCAN
<i>Senecio integerrimus</i>	Western Groundsel			SENINT
<i>Senecio pauperculus</i>	Balsam Groundsel			SENPAU
<i>Silene drummondii</i>	Drummond Campion			SILDRU

<i>Sisymbrium altissimum</i>	Tumblemustard	X		SISALT
<i>Sisyrinchium montanum</i>	Mountain Blue-eyed Grass			SISMON
<i>Smilax herbacea</i>	Carrion-flower			SMIHER
<i>Solanum rostratum</i>	Buffalo Bur		B	SOLROS
<i>Solanum triflorum</i>	Cut-leaved Nightshade		B, 97	SOLTRI
<i>Solidago canadensis</i>	Canada Goldenrod			SOLCAN
<i>Solidago gigantea</i>	Late Goldenrod			SOLGIG
<i>Solidago missouriensis</i>	Missouri Goldenrod			SOLMIS
<i>Solidago mollis</i>	Velvety Goldenrod			SOLMOL
<i>Solidago ptarmicoides</i>	Sneezewort Aster			SOLPTA
<i>Solidago rigida</i>	Stiff Goldenrod			SOLRIG
<i>Sparganium eurycarpum</i>	Broadfruted Bur-reed			SPHCOC
<i>Sphaeralcea coccinea</i>	Red Globe-mallow			STAPIN
<i>Stanleya pinnata</i>	Bushy Princesplume			STARUN
<i>Stephanomeria runcinata</i>	Runcinate-leaved Skeltonweed			STERUN
<i>Suaeda calceoliformis</i>	Pahute Weed			SUACAL
<i>Taraxacum laevigatum</i>	Red-seeded Dandelion	X		TARLAE
<i>Taraxacum officinale ssp ceratophorum</i>	Horned Dandeloin	X		TAROFF
<i>Thalictrum dasycarpum</i>	Purple Meadowrue			THADAS
<i>Thalictrum sparsiflorum</i>	Fewflowered Meadowrue		B	THASPA
<i>Thalictrum venulosum</i>	Veiny Meadowrue			THAVEN
<i>Thermopsis rhombifolia</i>	Round-leaved Thermopsis		B	THERHO
<i>Thlaspi arvense</i>	Field pennycress	X	B	THLARV
<i>Townsendia hookeri</i>	Hooker's Townsendia			TOWHOO
<i>Tradescantia occidentalis</i>	Prairie Spiderwort			TRAOCO
<i>Tragopogon dubius</i>	Goat's Beard	X		TRADUB
<i>Trifolium arvense</i>	Hare's Foot	X		TRIARV
<i>Trifolium repens</i>	White Clover	X		TRIREP
<i>Triglochin maritimum</i>	Seaside Arrow-grass			TRIMAR
<i>Triodanis leptocarpa</i>	Western Venus'-looking- glass		97	TRILEP
<i>Triodanis perfoliata</i>	Clasping Venus'-looking- glass		EH	TRIPER
<i>Typha angustifolia</i>	Lesser Cattail			TYPANG
<i>Typha latifolia</i>	Common Cattail			TYPLAT
<i>Urtica dioica</i>	Stinging Nettle	X	B	URTCIO
<i>Vaccaria pyramidata</i>	Cowherb	X		VACPYP
<i>Verbena bracteata</i>	Bracted Vervain		B	VERTBRA
<i>Verbascum thapsus</i>	Common Mullein	X		VERTHA
<i>Veronica americana</i>	American Speedwell		B	VERAME
<i>Veronica anagallis-aquatica</i>	Water Speedwell			VERANA
<i>Veronica peregrina</i>	Purslane Speedwell		B	VERPER
<i>Vicia americana</i>	American Vetch		B	VICAME
<i>Viola canadensis</i>	Canada Violet			VIOCAN
<i>Viola nephrophylla</i>	Northern Bog Violet			VIONEP
<i>Viola vallicola</i>	Valley Yellow Violet		B	VIOVAL
<i>Xanthium strumarium</i>	Common Cocklebur	X		XANSTR
<i>Xylorhiza glabriuscula</i>	Smooth Woody Aster			XYLGLA
<i>Zannichellia palustris</i>	Horned Pondweed			ZANPAL
<i>Zigadenus venenosus</i>	Meadow Death-camas			ZIGVEN
<i>Zizia aptera</i>	Heart-leaved Alexanders		B	ZIZAPT

FERNS AND FERN ALLIES

<i>Botrychium virginianum</i>	Virginia Grape-fern			BOTVIR
<i>Cystopteris fragilis</i>	Brittle Bladder-fern			CYSFRA
<i>Equisetum arvense</i>	Field Horsetail			EQUARV
<i>Equisetum laevigatum</i>	Smooth Scouring-rush			EQULAE
<i>Selaginella densa</i> var <i>densa</i>	Compact Selaginella			SELDEN

APPENDIX D. PHOTOS AND ILLUSTRATIONS OF SENSITIVE PLANT SPECIES

The following pages present the available illustrations, close-up photos, and habitat photos of the Carter County sens species, arranged alphabetically by species scientific name.

SPECIES	ILLUSTRATION	CLOSE-UP SHOT	HABITAT SH
<i>Amorpha canescens</i>	X	X	
<i>Asclepias ovalifolia</i>	X	X	X
<i>Asclepias stenophylla</i>	X	X	X
<i>Astragalus barri</i>	X	X	X
<i>Astragalus racemosus</i>	X	X	
<i>Chenopodium subglabrum</i>	X	X	X
<i>Cyperus schweinitzii</i>	X	X	X
<i>Dalea villosa</i>		X	X
<i>Eriogonum visheri</i>	X	X	X
<i>Linaria canadensis</i>	X		
<i>Maianthemum canadense</i>	X		
<i>Mirabilis hirsuta</i>		X	
<i>Penstemon angustifolius</i>		X	
<i>Phlox andicola</i>		X	
<i>Physaria brassicoides</i>		X	
<i>Psoralea hypogaea</i>	X	X	X
<i>Quercus macrocarpa</i>	X	X	X
<i>Solidago ptarmicoides</i>	X	X	



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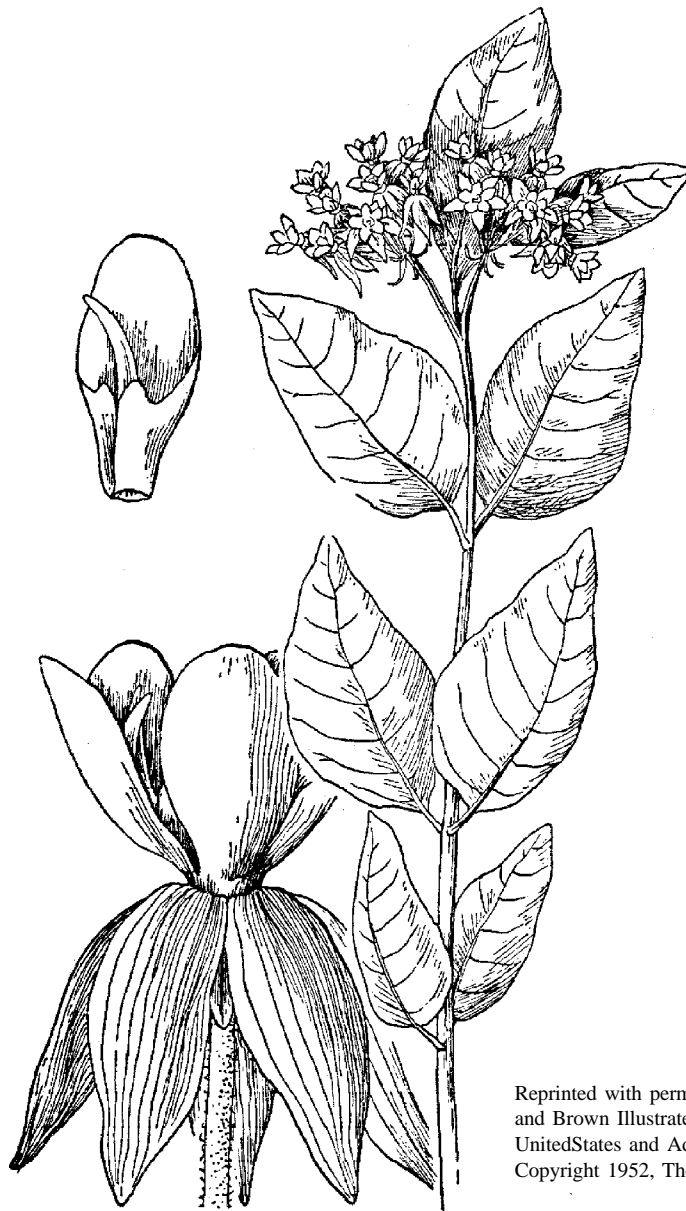
AMORPHA CANESCENS

LEAD PLANT

Lead Plant is a shrub with few to several, erect or ascending, simple or sparingly branched stems, which are 3-8 dm high. In marginal sites, the plant may die back to near the base each year. The alternate leaves have a short petiole and 27-41 narrowly elliptic leaflets, which are 8-15 mm long. Foliage is covered with very dense, short white hairs, giving the plant a hoary appearance. The violet flowers are borne in dense spike-like inflorescences, that are 7-15 cm long and arise on long stems from the leaf axils. Each small flower has a single petal longer than the densely hairy calyx that is ca. 2 mm long. There are 10 orange stamens exserted beyond the petal. The glandular and hairy fruits are ca. 4 mm long and egg-shaped with a long beak.

Flowering in late June-early July.

Lead Plant could be confused with members of the genus *DALEA* or *PSORALEA*, but these plants are not true shrubs, and they have flowers with more than 1 petal.



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ASCLEPIAS OVALIFOLIA **OVALLEAF MILKWEED**

Ovalleaf Milkweed is a rhizomatous perennial with usually solitary slender stems 2-6 dm high. The erect to spreading, opposite leaves have petioles which are up to 1 cm long, and broadly lance-shaped to elliptic blades which are 4-8 cm long with entire margins. Leaves are moderately long, hairy beneath, and the sap is milky. 1-3 umbrella-shaped, stalked clusters of 8-20 flowers are at the top of the stem or in the axils of the upper leaves. Each greenish-white to cream flower is 8-10 mm high and borne on a hairy stalk that is up to 20 mm long. Flowers have 5 reflexed corolla lobes which are 5-6 mm long, and 5 erect hoods which are 4-5 mm long and rounded at the tip; these hoods surround a greenish or yellowish central column, and each has a conical horn inside. The erect spindle-shaped fruits are 6-8 cm long and ca. 1 cm wide. Each fruit has numerous seeds, each with a light brown tuft of hairs that is 18-35 mm long.

Approached peak flowering on 2 July 1994, with a few plants in very early stages of fruit formation.

ASCLEPIAS VIRIDIFLORA and *A. SPECIOSA* also have broad leaves, but the former lacks horns within the hoods, and the latter has pink to purple flowers.



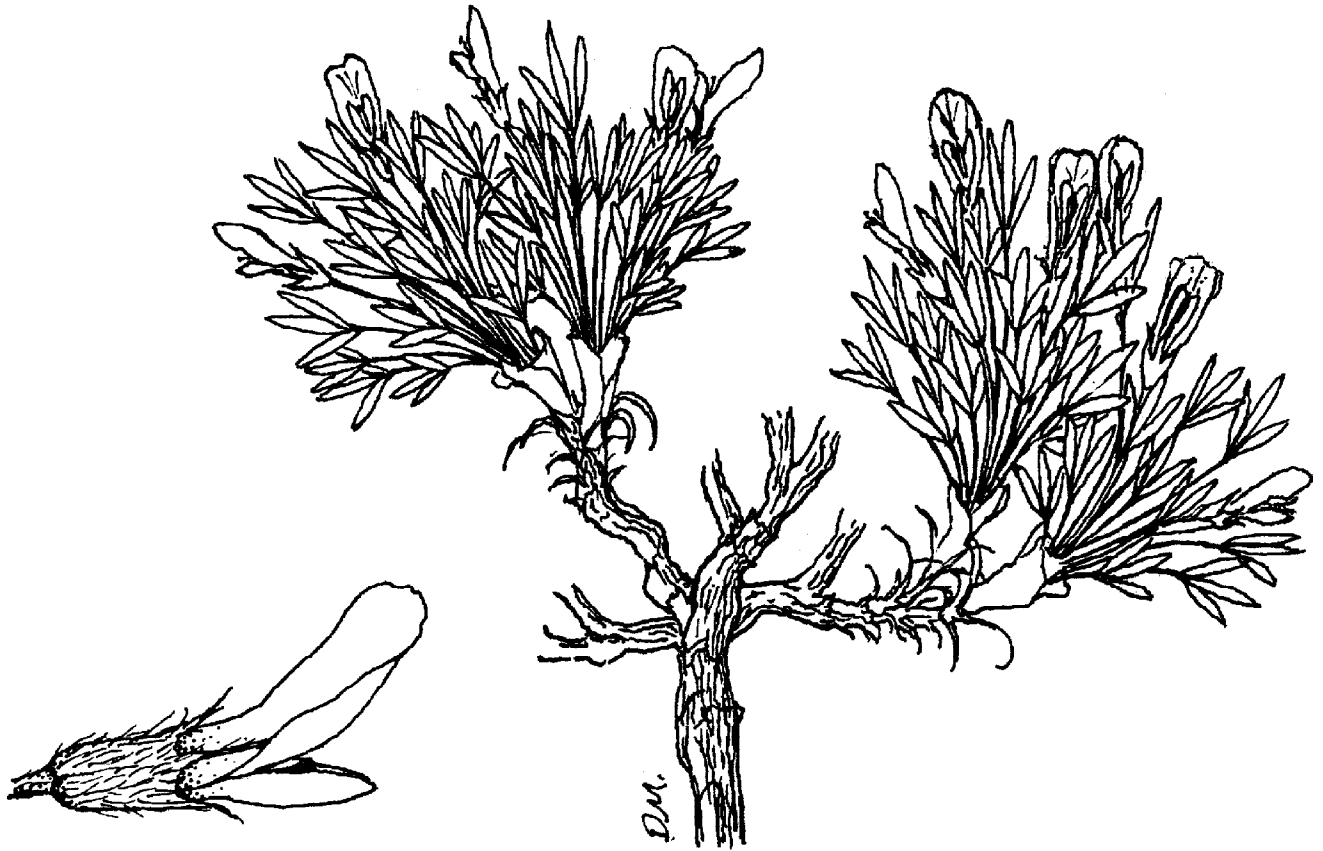
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ASCLEPIAS STENOPHYLLA **NARROWLEAF MILKWEED**

Narrowleaf Milkweed is a perennial herb with few, erect and usually unbranched stems that are decumbent or upright, 2-8 dm high and arise from a thick, woody root. The alternate or opposite leaves are 8-18 cm long, but only 1-5 mm wide. Foliage is moderately to sparsely hairy, and the sap is milky. Umbrella-shaped clusters of 10-25 flowers are nearly stemless in the leaf axils on the upper half of the stem. Each greenish-white to yellow flower is only 7-9 mm long and is borne on a hairy stalk that can be up to 1 cm long. Flowers have 5 reflexed corolla lobes which are ca. 5 mm long, and 5 erect hoods that are distinctly 3-lobed at the tip and which surround a central column. Erect spindle-shaped fruits are 9-12 cm long and less than 1 cm wide. Each fruit has numerous seeds, each with a white tail that is ca. 3 cm long.

Flowering in June-early July.

It resembles narrow-leaved forms of *ASCLEPIAS VIRIDIFLORA* but has flowers with horns. Both *ASCLEPIAS PUMILA* and *A. VERTICILLATA* also have narrow leaves, but often filiform and less than 1.5 mm wide. A hand lens reveals the three-lobed hoods of *A. STENOPHYLLA* that are diagnostic.



ASTRAGALUS BARRII
BARR'S MILKVETCH

Barr's Milkvetch is a perennial that grows in low, dense mats. Leaves have 3 narrowly lance-shaped leaflets and are 1-4 cm long, densely covered with short white hairs. Stipules at the leaf bases are membranous. Purple or pinkish-purple flowers that are shaped like pea flowers are borne in a narrow, open, few-flowered inflorescence. The petals are 7-17 mm long. The calyx is 3-5 mm long and densely covered with long, white hairs. The sparsely white, hairy pod is narrowly elliptical, 4-8 mm long, and 1-2 mm in diameter.

Flowering in May-early June, fruiting late May-June.

The only other mat-forming species with 3-leaflets in the range of *A. BARRII* in Montana are *A. GILVIFLORUS* and *A. HYALINUS*. Both have white flowers and a longer calyx tube (6-16 mm) than *A. BARRII* calyx tube length (2.8-5 mm). They also have peduncles which are short (<3.5 mm) or absent compared to *A. BARRII* peduncle length (7-24 mm).



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ASTRAGALUS RACEMOSUS

RACEME MILKVETCH

Raceme Milkvetch is a coarse, herbaceous perennial with few to many erect stems, 15-70 cm high, and arising from a woody taproot and branched rootcrown. The pinnately compound leaves are 4-15 cm long with 11-31 narrowly to broadly elliptic leaflets. Foliage is thinly to densely covered with short hairs. Inflorescences with 15-70 densely clustered flowers arise from the axils of the upper leaves. The nodding, whitish flowers are 16-21 mm long with a partially reflexed upper petal and purplish tinged lower petals. The calyx is 8-11 mm long and glabrous or with scattered hairs. The pendant, oblong-elliptic pods have a basal, 3-7 mm long stalk, are glabrous, triangular in cross section, with 3 sides that are nearly flat and equal-width, and 15-30 mm long.

Flowering in late June-early July.

The combination of coarse, erect stems, short pubescence, and pendant pods, triangular in cross-section, is diagnostic of this species in the n. Great Plains. The more common *A. DRUMMONDII* is similar but has pods dorsiventrally compressed with 2 parallel grooves on the bottom, and has foliage with long spreading hairs.



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CHENOPODIUM SUBGLABRUM
SMOOTH GOOSEFOOT

Smooth Goosefoot is an annual with erect, simple, or highly stems 2-3 (8) dm high. The alternate leaves are linear with entire margins, single veined, glabrous, up to 3 cm long. Flowers are small, green, and grouped in remote clusters on the branched stem. Each flower lacks petals but has 5 glabrous sepals and 5 stamens. The 1-seeded fruit is compressed hemispheric and is relatively large; 1-2 mm across, exposing a jet-black fruit at maturity that readily separates from the pericarp (fruit wall).

Fruiting in early July.

CHENOPODIUM SUBGLABRUM sometimes occurs with and is related to *C. LEPTOPHYLLUM*. They both have linear, single-veined leaves but the latter are farinose white. *CHENOPODIUM LEPTOPHYLLUM* also has densely clustered glomerules, a relatively unbranched growth form, fruits usually 1 mm or smaller, and seeds which do not detach from the pericarp.



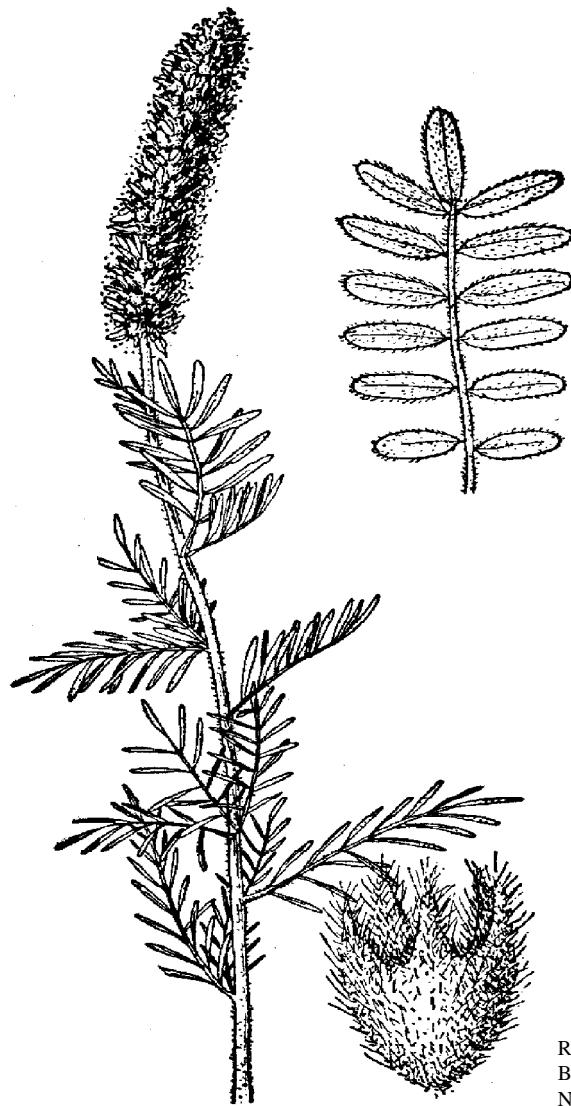
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CYPERUS SCHWEINITZII ***SCHWEINITZ' FLATSEGE***

Schweinitz' Flatsedge is a grass-like perennial with stems that are 10-40 cm high, arising from short, irregularly swollen rhizomes. The leaves are 1-4 mm wide and located mostly near the base of the plant. The inflorescence is subtended by 3-6 long leaf-like bracts, some of which are wider than the leaves. The inflorescence is made up of ascending clusters of flattened spikelets that are 5-25 mm long and borne on stalks that are very short to long. The flowers are crowded opposite each other and consist only of a small, pointed scale, which is ca. 3-4 mm long and subtends 3 stamens and an ovary. The seed is triangular in cross-section.

Flowering reported early July. Mature fruit from late June-August.

This is our only perennial CYPERUS and is the only one occurring in upland habitat.



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DALEA VILLOSA

SILKY PRAIRIE CLOVER

Silky Prairie Clover is a perennial herb with ascending or lax, branched stems that are 20-35 cm high, and which arise from red-orange roots and a rootcrown. The alternate, pinnately compound leaves are 2-4 cm long and have 11-21 linear leaflets. The foliage has numerous sunken glands and is densely long and hairy. The pink to rose-purple flowers are densely crowded in cylindrical spikes that are 3-12 cm long, at the ends of stems and branches. Each flower is 4-6 mm long and has 4 separate petals, a densely spreading, hairy, 5-lobed, cup-shaped calyx, and 5 stamens that are usually longer than the petals. The narrowly egg-shaped pods are 2-3 mm long and densely long and hairy.

Flowering in late July-August; fruiting in late August.

Other *DALEA* in Montana usually have 11 or more leaflets, and are not as conspicuously hairy. The combination of the long, hairy calyx and the 5 stamens further separate this species from other *DALEA* and from species of *PSORALEA* and *AMORPHA*.

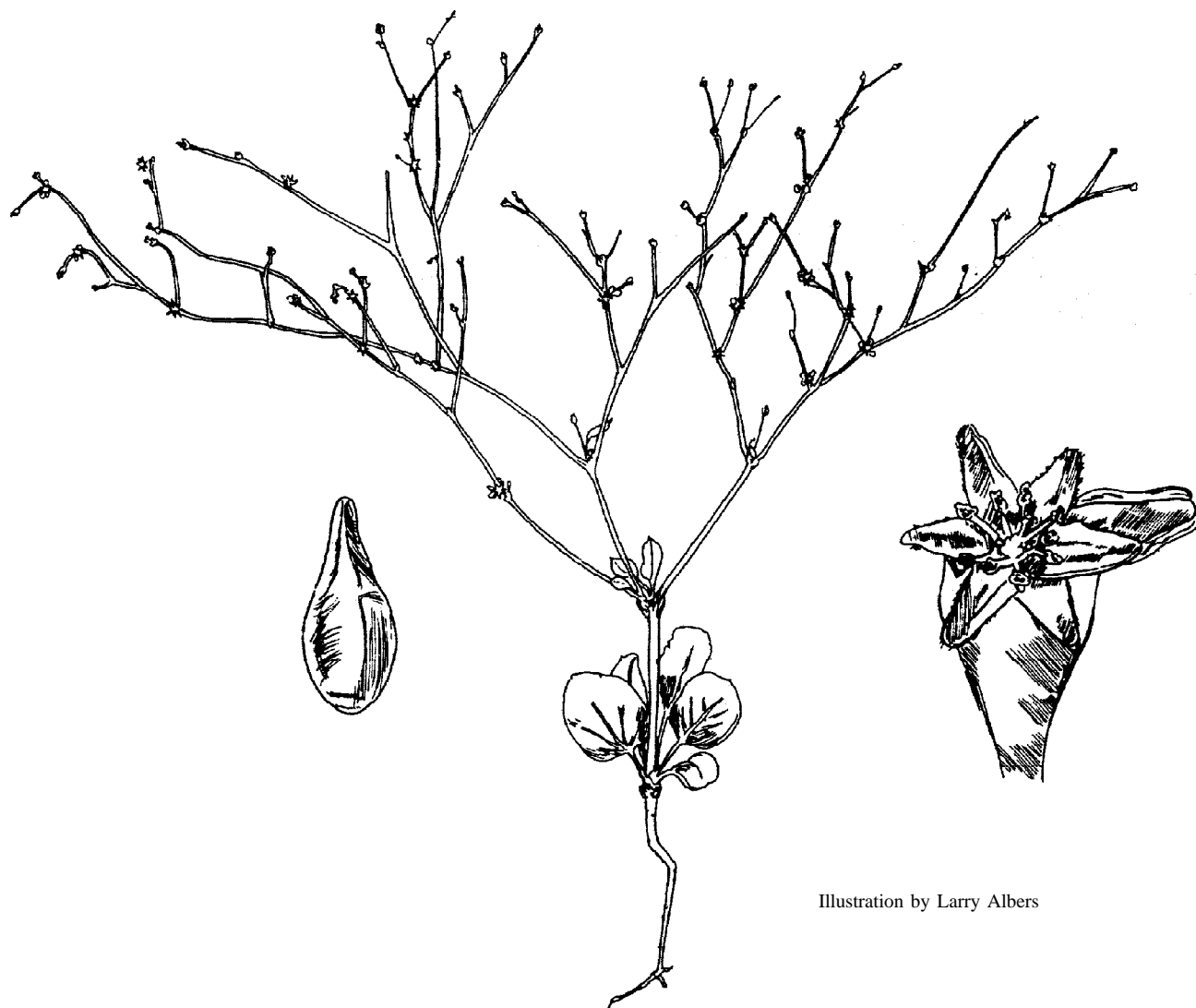


Illustration by Larry Albers

ERIOGONUM VISHERI
DAKOTA BUCKWHEAT

Dakota Buckwheat is an annual with slender taproot and single stem much branched, 15-25 cm tall. Leaves are glabrous, in a basal rosette, the blades ovate to reniform, 15-20 mm long. Bracts of the inflorescence are elliptic, involucre are on slender peduncles or sessile in an erect or spreading inflorescence. Flowers are 1-few per involucre, yellow.

Readily distinguished from the two other annual species of *ERIOGONUM* in Montana; *E. ANNUUM* has cauline leaves rather a distinct basal rosette and *E. CERNUUM* has strongly reflexed involucre peduncles rather than an erect to spreading inflorescence.



Illustration by Jeanne R. Janish, From
'Vascular Plants of the Pacific Northwest'

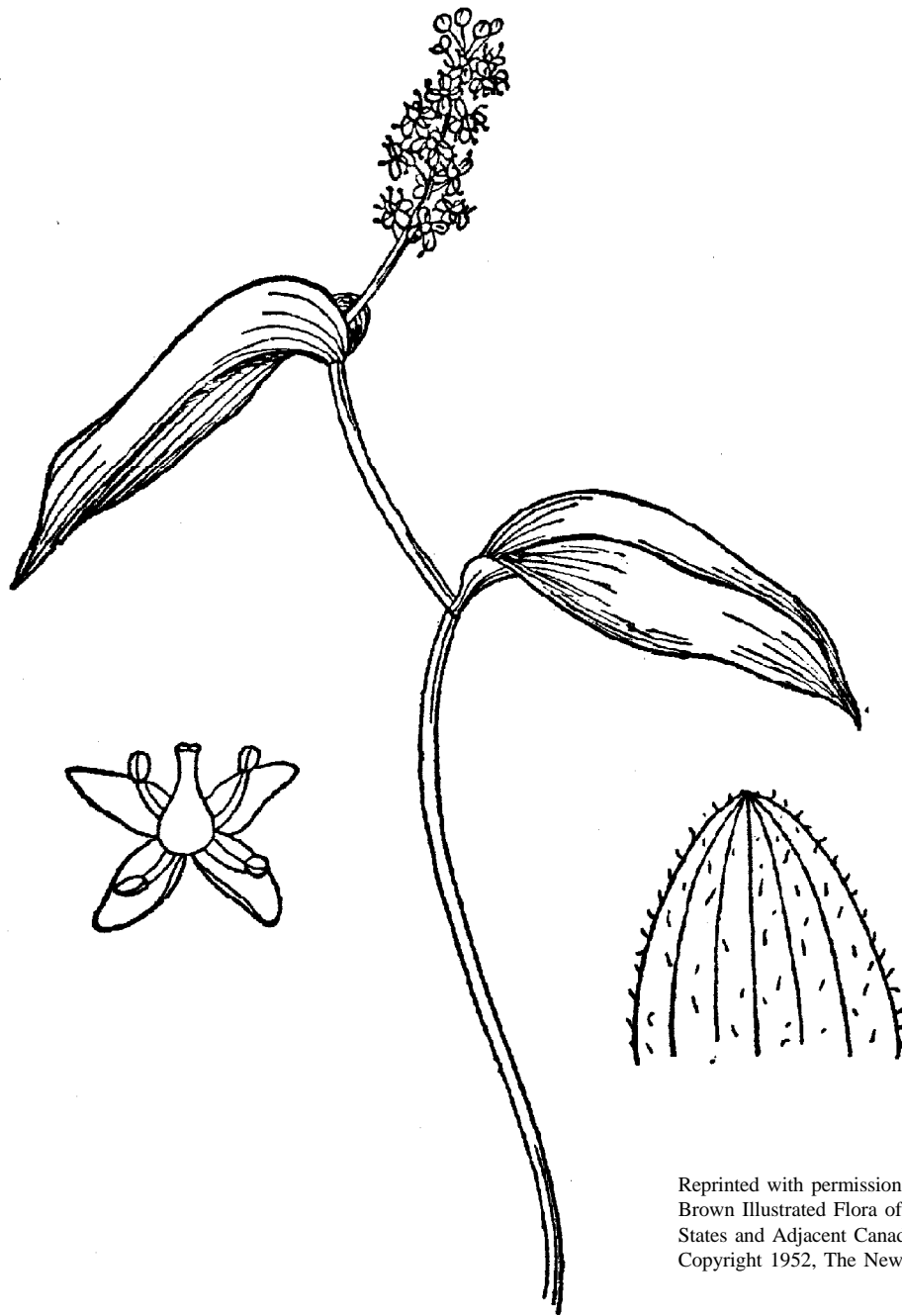
LINARIA CANADENSIS

BLUE TOADFLAX

Blue Toadflax is a slender annual with erect, unbranched stems that are 1-5 dm tall. There is a rosette of prostrate stems at the base, the leaves of which are narrowly oblong, 5-10 mm long, and opposite or in whorls of 3. Stem leaves are narrower, and the lower are opposite or in whorls of 3, becoming alternate above. Foliage is glabrous, often with a thin, bluish, waxy coating. Short-stalked flowers are borne in an elongating, spike-like inflorescence. The snapdragon like blue flowers are 8-12 mm long and have 5 sepals and a 2-lipped corolla. The lower lip is horizontal and 3-lobed, while the upper is 2-lobed and erect. There is a linear, downcurved spur that is 2-11 mm long and located at the base of the corolla. The fruit is a globose, many-seeded capsule that is 2-4 mm high.

Flowering and fruiting mid-June-August.

The blue, spurred flowers and basal rosette of prostrate stems are diagnostic.



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MAIANTHEMUM CANADENSE
WILD LILY-OF-THE-VALLEY

Wild Lily-of-the-valley is a rhizomatous, perennial herb with unbranched, sparsely hairy, zig-zag-shaped stems that are 8-20 cm high. The 2-3 alternate, elliptical leaves are ca. 6 cm long and have a shallow basal lobe or short petiole that partly surrounds the stem. The small, white flowers are borne in a tightly branched terminal inflorescence. The flowers have 4 stamens and 4 narrow, undifferentiated perianth segments, or tepals, that are ca. 2 mm long. The ovary matures into a red, 1-2-seeded berry that is ca. 3 mm wide.

Flowering in June.

Species of *SMILACINA* and *DISPORUM* have more leaves and much larger fruits. Both genera have 6 tepals and 6 stamens.



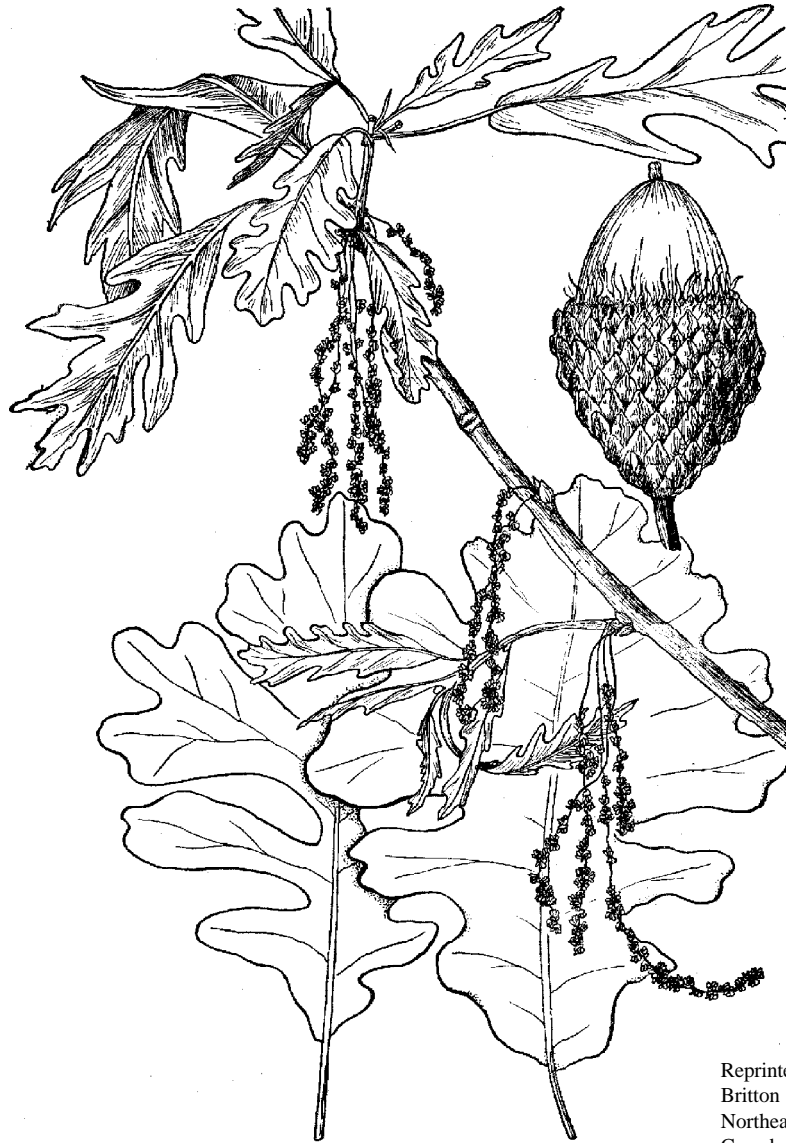
Illustration by Jeanne R. Janish,
From 'Vascular Plants of the Pacific Northwest'

PSORALEA HYPOGAEA
LITTLE INDIAN BREADROOT

Little Indian Breadroot is a perennial herb with a deep, club-shaped root that is up to 6 cm long and surmounted by a subterranean connecting stem. Above ground, the plant consists of a rosette of long-petioled leaves that are palmately divided into 3-7 linear-elliptic leaflets that are 25-50 mm long. The foliage is covered with dot-like glands and dense, white appressed hairs, but the upper leaf surfaces become glabrous with age. Blue, pea-like flowers are borne in condensed spikes arising among the bases of the leaf petioles at or barely above ground-level. The tubular calyx is 6-9 mm long and has 4 long, narrow lobes and a fifth that is longer and broader. The upper petal is 10-13 mm long and held forward. The hairy pods are egg-shaped, ca. 5 mm long, and each has a beak that is 5-13 mm long.

Flowering end of May-June.

PSORALEA ESCULENTA has a distinct flowering stem with spreading pubescence on the stem and leaf petiole, while *PSORALEA HYPOGAEA* is stemless and has appressed pubescence.



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QUERCUS MACROCARPA
BUR OAK

Bur Oak is a small to large tree. Its bark is deeply furrowed and twigs are stout. The alternate, oblong-elliptic leaves are 10-20 cm in length and are deeply to shallowly lobed, with the terminal lobe being the largest. Leaves are dark green and shiny above but silvery below with fine, star-shaped hairs. Male flowers of 5-10 stamens are borne in long, loose, pendulous inflorescences from the leaf axils. 1 to several female flowers occur in the axils of new leaves. The acorn is up to 2-4 cm long, ellipsoidal, and the top half or more is enclosed by a roughened, fringe-margined cup.

Flowering in April-May.

This is Montana's only native oak.



Illustration by Janet Wingate

SOLIDAGO PTARMICOIDES

PRAIRIE ASTER

Prairie Aster has stems that are 1-7 dm high and clustered on a woody-thickened, branched rootcrown. Leaves are alternate, glabrous, firm, and 3-veined. The narrowly lance-shaped leaves near the base of the plant have entire margins and are petiolate and up to 20 cm long, while those on the upper stem are shorter, strap-shaped, and lacking petioles. The 3-60 flower heads are borne in an open, flat-topped inflorescence. The glabrous, overlapping involucre bracts of each head are 5-7 mm long, each with a greenish apex and a prominent, thickened midrib. The 10-25 rayflowers are white and 5-9 mm long, and the numerous disk flowers are white. The achene is glabrous and has a pappus of bristles that are thickened toward the top.

Flowering August-September.

This species differs from other *SOLIDAGO* in having white flowers, resembling an *ASTER*. It can be distinguished from the latter by its flat-topped inflorescence, its thickened, involucre bracts that are often blunt at the tips, the thickened pappus bristles, and 3-veined leaves.



Photo by John Challey

Amorpha canescens
Lead Plant



Photo by Bonnie Heidel

Asclepias ovalifolia
Ovalleaf Milkweed



Photo by Bonnie Heidel

***Asclepias ovalifolia* Habitat**



Photo by Bonnie Heidel

Asclepias stenophylla
Narrowleaf Milkweed

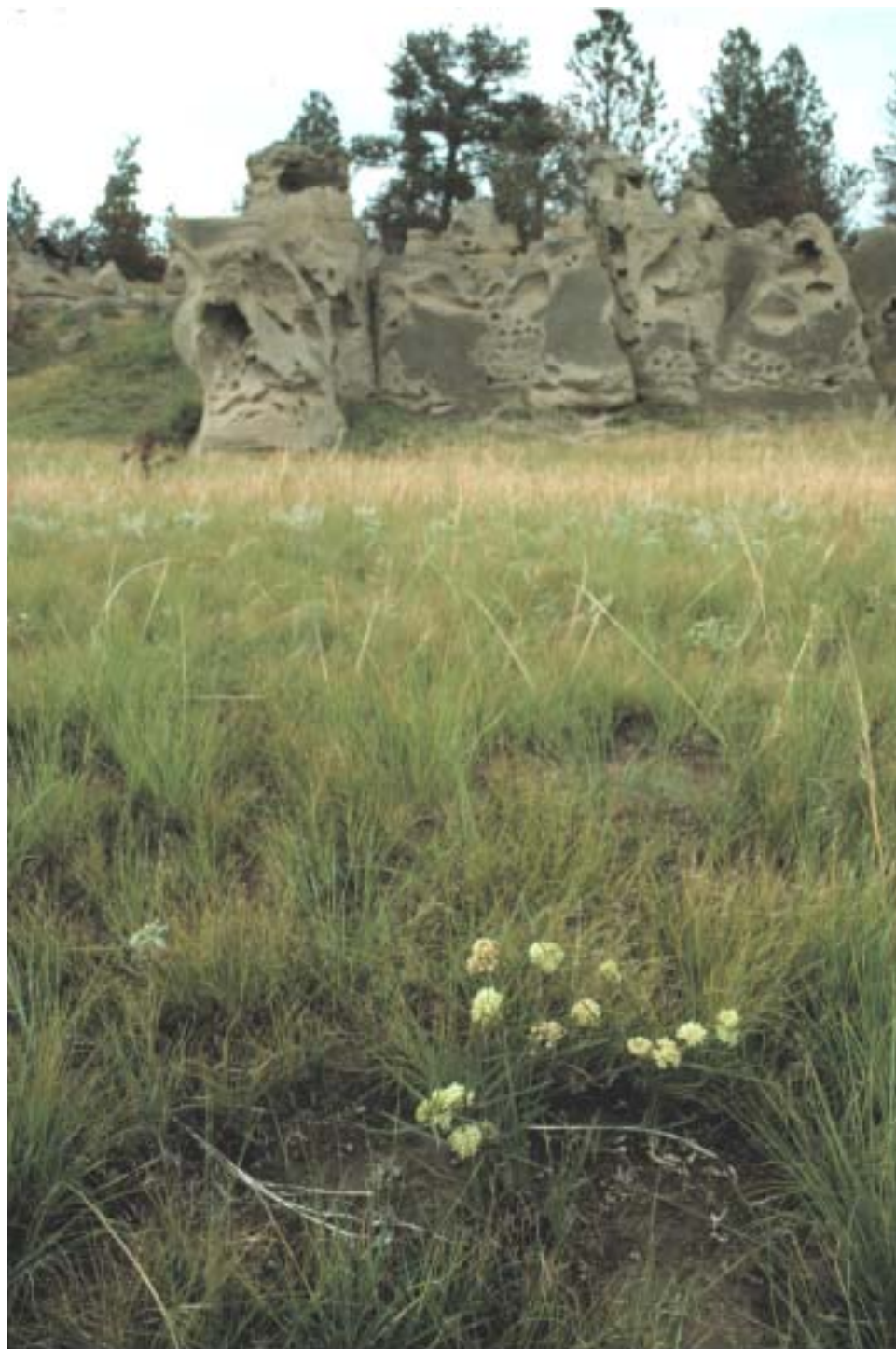


Photo by Bonnie Heidel

***Asclepias stenophylla* Habitat**



Photo by Dee Strickler

Astragalus barrii
Barr's Milkvetch



Photo by Steve Shelly

***Astragalus barrii* Habitat**



Photo by Harold Kantrud

Astragalus racemosus
Raceme Milkvetch



Photo by Bonnie Heidel

Chenopodium subglabrum
Smooth Goosefoot



Photo by Bonnie Heidel

***Chenopodium subglabrum* Habitat**



Photo by John Challey

Cyperus schweinitzii
Schweinitz's Flatsedge



Photo by Bonnie Heidel

***Cyperus schweinitzii* Habitat**



Photo by Bonnie Heidel

Dalea villosa
Silky Prairie Clover



Photo by Bonnie Heidel

***Dalea villosa* Habitat**



Photo by Dave Ode

Eriogonum visherii
Visher's Buckwheat



Photo by Bonnie Heidel

***Eriogonum visherii* Habitat**



Photo by John Challey

Mirabilis hirsuta
Hairy Four-O'Clock



Photo by Charmaine Refsdal-Delmatier

Penstemon angustifolius
Narrowleaf Penstemon



Photo by Bonnie Heidel

Phlox andicola
Plains Phlox



Photo by Bonnie Heidel

Physaria brassicoides
Rydberg Double Twinpod



Photo by Bonnie Heidel

Psoralea hypogaea
Little Indian Breadroot



Photo by Bonnie Heidel

***Psoralea hypogaea* Habitat**



Photo by Bonnie Heidel

Quercus macrocarpa
Bur Oak



Photo by Keith Dueholm

***Quercus macrocarpa* Habitat**



Photo by Bill Jennings

Solidago ptarmicoides
Prairie Aster